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Stigmella species on the Wild Service Tree, *Torminalis glaberrima*, confused, overlooked and found again (Lepidoptera, Nepticulidae)

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Abstract. The rare leafmining pygmy moth *Stigmella torminalis* (Wood, 1890) was found in 2021 in Germany, Hessen, Volkmarsen-Hörle, for the first time in western Europe in more than a century. From 14 larvae found on *Torminalis glaberrima* (Gand.) Sennikov & Kurtto (= *Sorbus torminalis* (L.) Crantz), eight adults emerged the following spring. The species was found again in 2022, and also in Germany in three localities in Rheinland-Pfalz, and is recorded as new from North Macedonia and Belgium, and possibly Georgia. By a focused search on the same hostplant, leafmines of *S. hahniella* (Wörz, 1937) were also found again in Germany for the first time in 90 years, in Baden-Württemberg, Thüringen, as newly in Rheinland-Pfalz, France and Georgia. Both species are compared with *S. mespilicola* (Frey, 1856), which also feeds on this host. *Stigmella mespilicola* is recorded as new from Albania, Bosnia, Bulgaria and Luxemburg. A key to leafmines of these species is provided. All old records of both species are reviewed, the majority of those specified as *Stigmella* (or *Nepticula*) *torminalis*, usually based on leafmines, being incorrect or dubious, but some old records from Hungary are shown to be correct. *Stigmella torminalis* has only been found on *Torminalis glaberrima*, with larvae only from late June to early August, and adults emerging the next spring. Records from other hosts or during the autumn are incorrect.

Zusammenfassung. Die seltene Zwergminiermotte *Stigmella torminalis* (Wood, 1890) wurde 2021 in Hessen, Volkmarsen-Hörle, erstmals seit mehr als einem Jahrhundert wieder in Westeuropa gefunden. Aus 14 auf *Torminalis glaberrima* (Gand.) Sennikov & Kurtto (= *Sorbus torminalis* (L.) Crantz) gefundenen Raupen schlüpften im darauffolgenden Frühjahr acht Falter. Die Art wurde 2022 wieder gefunden, außerdem an drei Orten in Rheinland-Pfalz, und wird als neu aus Nordmazedonien und Belgien sowie möglicherweise aus Georgien gemeldet. Blattminen von *S. hahniella* (Wörz, 1937) auf der gleichen Wirtspflanze wurden nach 90 Jahren durch eine gezielte Suche auf der Wirtspflanze in Baden-Württemberg ebenfalls wieder in Deutschland gefunden und ist neu für Rheinland-Pfalz und auch neu für Frankreich und Georgien. Beide Arten werden mit *S. mespilicola* (Frey, 1856) verglichen, die auf derselben Wirtspflanze vorkommt, zudem wird ein Schlüssel zu den Blattminen geliefert. Alle alten Aufzeichnungen beider Arten werden überprüft, wobei die meisten Nachweise von *S. torminalis*, die in der Regel auf Blattminen beruhen, falsch oder zweifelhaft sind, während einige Nachweise aus Ungarn sich als richtig erweisen. *Stigmella torminalis* wurde nur auf *Torminalis glaberrima* gefunden, und die Raupen nur von Ende Juni bis Anfang August, wobei die Falter im nächsten Frühjahr schlüpfen. Aufzeichnungen von anderen Wirten oder aus dem Herbst sind falsch. *Stigmella mespilicola* wird neu aus Albanien, Bosnien, Bulgarien und Luxemburg gemeldet.

Introduction

There are many reasons why species are considered rare. Lepidoptera species that escape common detection methods, such as light collecting, are often considered rare, although they probably are just not collected easily. Once a better methodology is discovered they may suddenly appear to be rather common. Other species occur in low densities and can be considered naturally rare and the chance to find them is very low (Fattorini et al. 2013). Leafmining moths are often relatively easily discovered by the characteristic leafmine they produce, and rare species may either have an as yet undiscovered hidden life style (e.g. *Bohemannia auriciliella* (Joannis, 1909) (Schulz and van Nieukerken 2020), or they are hard to differentiate from related species without more time consuming methods such as rearing or DNA barcoding.

Stigmella torminalis (Wood, 1890), one of the species we are discussing here, is considered to be one of the rarest leafmining pygmy moths in Europe. After its discovery in England it was never again found in the British Isles, and although several reports on the European continent existed, almost all appeared to be misidentifications or impossible to verify, until it was shown that European collections harbour a large series of the species, reared in the late 19th century by Eppelsheim in Germany, Pfalz, near Grünstadt (Schoorl et al. 1985). Since then, the only other reliable report until recently was from the Crimea (Navickaitė et al. 2014).

The unexpected recent finding of this species in Germany, Hessen by the second author, already reported briefly (Robrecht et al. 2024), prompted us to summarise the knowledge of this species and the other two *Stigmella* species on its hostplant, *Torminalis glaberrima* (Gand.) Sennikov & Kurtto (=*Sorbus torminalis* (L.) Crantz)), particularly *Stigmella mespilicola* (Frey, 1856), with which it was often confused. It also led to more discoveries, including the rediscovery of *Stigmella hahniella* (Wörz, 1937), that had not been reported with certainty from Germany since its description.

Both *S. torminalis* and *S. hahniella* are members of the *Stigmella oxyacanthella* group, a monophyletic group in the large "Core *Stigmella*" cluster in the genus *Stigmella* Schrank, 1802. The group has 28 named species in the Holarctic region, all associated with Rosaceae trees or shrubs. The European species were revised by Schoorl et al. (1985). On the other hand, *S. mespilicola* is member of the *S. hybnerella* group, which is sister group to the *oxyacanthella* group and has 10 Holarctic members, likewise associated with Rosaceae trees or shrubs (Doorenweerd et al. 2016; van Nieukerken et al. 2016).

The Wild service tree

Torminalis glaberrima (Gand.) Sennikov & Kurtto (Rosaceae), formerly widely known as *Sorbus torminalis* (L.) Crantz, is in English known as the Wild Service Tree, in German as "Elsbeere". The former genus *Sorbus* L. was shown in molecular phylogenies to be polyphyletic (Campbell et al. 2007), leading to splitting off the genera *Aria* (Pers.) Host, *Chamaemespilus* Medik., *Cormus* Spach and *Torminalis* Medik., plus a number of hybrid genera, leaving in Europe the Rowan (*Sorbus aucuparia* L.) as the sole member of the genus *Sorbus* (Sennikov and Kurtto 2017). We follow this taxonomy, although some local floras maintain *Sorbus* as one large genus.

Torminalis Medik. comprises only one species, which is widespread in Central and South Europe, western Asia, mostly around the Black Sea and few localities in Northwest Africa; the northern limit is somewhere in Central Germany; the species usually occurs in very low densities (Welk et al. 2016). In England and Wales the tree is considered a useful indicator of ancient

woodland and hedgerows, particularly on soils derived from clays or from harder limestone (Roper 1993). In continental Europe the species grows particularly in woodland dominated by oaks, less commonly pine or beech, and usually occurs as single trees or in small groups. It is shade intolerant and often colonizes clearings or low density forests (Welk et al. 2016). Apart from the two monophagous *Stigmella* species, *S. torminalis* and *S. mespilicola*, the eriophyid mite *Eriophyes torminalis* Nalepa, 1926 is also a specialist of the tree (Ellis 2024). Otherwise many herbivores that use several rosaceous trees can also be found on *Torminalis* (Ellis 2024).

Material and methods

Material

Stigmella torminalis was rediscovered in 2021 during fieldwork in western Germany for preparation of an identification book for Nepticulidae (Robrecht et al. 2024). After that, the authors and several other people watched out for leafmines on Wild Service Tree, especially in Germany. EvN re-examined leafmines and moths in RMNH and other collections that were collected earlier. For an explanation of numbering of his field samples and registry numbers see van Nieukerken (2023).

Fieldwork essentially consisted of tracing host trees, sometimes using platforms like iNaturalist or observation.org for locating promising sites, and extensive searching for leafmines. Leafmines were photographed directly in the field and/or collected in plastic bags. Vacated leafmines, or leafmines with dead larvae were dried and pressed between blotting paper; from mines with larvae rearing of adults was attempted as, e.g., described by Robrecht et al. (2024). Some larvae, especially dead ones, were preserved in 96% ethanol for later DNA extraction. Leafmines of such larvae were photographed in the lab.

The lists of "Material examined" only contain material that the authors have seen personally. Material or observations of which photographs were available that made a positive identification possible are listed separately. Online observations of *S. mespilicola* are not given in the paper, but are present in the map. We obtained records from the following sources: https://observation.org/, https://oreina.org/artemisiae/index.php, BoldSystems (dataset DS-STITOR, https://dx.doi.org/10.5883/DS-STITOR) and GBIF Occurrence Download https://doi.org/10.15468/dl.ch6ph4.

Hostplant data of *Sorbus* s. lat. follow the classification discussed above (Sennikov and Kurtto 2017), although in most cases original labels give these species as, respectively, *Sorbus torminalis*, *Sorbus aria* and *Sorbus domestica*.

The complete set of data used for preparing the distribution maps is provided in GBIF dataset https://doi.org/10.15468/hde44g.

Abbreviations for depositories

HNHM – Hungarian Natural History Museum, Budapest, Hungary

MfN – Museum für Naturkunde, Berlin, Germany

NHMUK – Natural History Museum, London, UK

RMNH – Naturalis Biodiversity Center, Zoological Collections, Leiden, the Netherlands

SMNK – State Museum for Natural History, Stuttgart, Germany

SOFM – National Museum of Natural History, Bulgarian Academy of Sciences, Sofia, Bulgaria

ZMAN – Zoological Museum of Amsterdam, now part of RMNH

ZMUC – Natural History Museum of Denmark, Zoological Collections, Copenhagen, Denmark

ZSM – Bavarian State Collection for Zoology, Munich, Germany

Morphology

Genitalia were prepared according to standard techniques, those by EvN usually including DNA extraction and using Euparal as embedding medium; larval slides were prepared in the same way, see earlier papers (van Nieukerken et al. 2010).

Measurements

Measurements of genitalia were obtained from digital images, using calibrated scaling in the Zeiss AxioVision software. Capsule length was measured from middle of vinculum to middle of tegumen; valva length from tip of posterior process to ventral edge, excluding the sublateral process; phallus length was measured along the sclerotized tube. Genitalia measurements are rounded off to the nearest 5 µm. Forewing length was measured from tip of fringe to attachment on thorax, with a Zeiss SV11 stereomicroscope at a magnification of 20×. Antennal segment counts include scape and pedicel; they were counted on photographs or directly under the same stereo microscope.

Photography

DR photographed with a Panasonic Lumix GH5-camera and Olympus 60 mm-macro-objective. Leafmines and moths, both alive or prepared were photographed during the day, without direct sunlight or flash, but using a silver reflector for brightening. For leafmines transmitted light was used.

EvN photographed moths with an AxioCam MRc 5 digital camera attached to a motorized Zeiss SteREO Discovery V12, using the Module Extended Focus and Zeiss AxioVision software to prepare a picture in full focus from a Z-stack of ca 10–40 individual photos. Leafmines were photographed with an MRc 5 camera on a Zeiss Stereo SV11 microscope, using dark field illumination. Genitalia were photographed with the same camera on a manually operated Zeiss Axioskop H, without using extended focus.

Photographs of Hungarian specimens were taken using a Nikon D720 camera with a Nikon objective AF-S Micro Nikkor 105mm and Raynox DCR-250 magnifying lens, and stacking of images was performed with Helicon Remote (Version 3.9.10 W) and Helicon Focus (Version 8.1.1) software.

Photographs were edited with Adobe Photoshop (various versions), avoiding changes to the real object, but backgrounds were cleaned of excess debris and artifacts by using the healing brush and clone tools, or sometimes replaced by a uniform colour; tone and contrast are adjusted, and some sharpening was used.

Maps were prepared with QGIS 3.28.6, the distribution layer of *Torminalis glaberrima* being derived from Caudullo et al. (2017).

DNA barcoding

Our methodology has been described before (van Nieukerken et al. 2012; Doorenweerd et al. 2015). We present a neighbor-joining tree, under the Pairwise Distance model, of the selected taxa and some relatives, made with tools in BoldSystems version 4 (Ratnasingham and Hebert 2007). This tree is only for showing relative distances and not to be interpreted as phylogenetic tree. The DNA barcode data as used here are given in detail in the public BOLD dataset DS-STITOR (https://dx.doi.org/10.5883/DS-STITOR), including GenBank accession numbers.

Results

Stigmella torminalis (Wood, 1890)

Figs 1–5, 11–27, 30

Nepticula torminalis Wood, 1890. Lectotype ♂ (selected by Schoorl et al. (1985: 72). United Kingdom, England: "e.l. Sorbus torminalis, Tarrington, Dr Wood 10.7.[18]90, B.M. ♂ Genitalia slide 21870, NHMUK010920613. NHMUK. [Photos of moth and labels https://www.gbif.org/occurrence/3332473337]

Stigmella torminalis (Wood, 1890) Beirne, 1945. New combination.

Stigmella torminalis; important citations: Beirne 1945: 200; Emmet 1976: 257; Schoorl et al. 1985: 72; Johansson and Nielsen 1990: 173; Puplesis and Schoorl 1994: 36; Navickaitė et al. 2014: 157; Robrecht et al. 2024: 112.

Recognition. Adult (Figs 1–5). Forewing length ♂ 1.9–2.0 mm (n = 3), ♀ 1.9–2.1 mm (n = 3), wingspan ♂ 4.5–4.8 mm (n = 8), ♀ 4.0–4.8 (n = 8); antennae ♂ with 23–28 articles (n = 8), ♀ with 20–22 (n = 5). The combination of a black hair tuft and collar on the head and forewings with a broad brassy fascia that does not contrast strongly with the golden-brown wing base, are characteristic. However, some specimens from Hungary have an orange head tuft. Male without androconial scales, abdomen without anal tufts. *Stigmella regiella* (Herrich-Schäffer, 1855) has a very similar wing pattern, but an orange head tuft and in the male purple black androconial scales in the fringe; *S. mespilicola*, that also feeds on the same host, has also a black head and collar, but a more contrasting and narrower silver to golden fascia, and conspicuous black androconial scales in the male.

Male genitalia (Figs 11–14). Characterised by the very long phallus, and the valva with two distal points. They resemble those of the eastern European and Asian *S. aurora* Puplesis, 1984 which feeds on *Crataegus* and *Mespilus* (Puplesis and Schoorl 1994), and the Turkmenian *S. lanceolata* Puplesis, 1994 (hostplant unknown), but differ strongly from other European species. *Stigmella aurora* differs by the narrower pointed triangular process on valva and the somewhat shorter phallus (2 measurements: 280–300 µm) (Stonis and Rocienė 2013); judging from the original drawings (Puplesis 1994), *S. lanceolata* is almost inseparable from *S. aurora*. Measurements (n = 4): capsule length 170–205 µm, width 165–200 µm, valva length 145–155 µm, phallus length 350–415 µm. Ratio phallus:capsule length 1.9–2.3.

Female genitalia (Figs 15–17). A very long but thin corpus bursae and round, conspicuous and wrinkled accessory sac are characteristic. The related species *S. hahniella* and *S. regiella* have an elongate accessory sac. Very different from *S. mespilicola* that has a strongly coiled accessory sac (Fig. 46).

Leafmines (Figs 18–25, 30). Egg always on leaf underside on or close to a main vein (Fig. 25). Mine starts as rather straight gallery, often following a vein for a short stretch, with a narrow continuous black frass line in middle; gradually widening in final instar, mine continuously changing direction; frass getting somewhat wider, slightly zigzagging, but remaining continuous and not more than 1/3 mine width. In dried mines the frass often becomes broken in places.

Larva: in mine almost transparent, yellow outside, paired prothoracic sclerite dark brown to black, often hiding head capsule, paired brains brown and well visible, larva with dorsum upwards.

Cocoon: pale orange-brown (T. Muus, personal information).

Distribution (Fig. 27). So far known from one locality in England (type locality, where apparently extinct), Germany: few records in Rheinland-Pfalz, Hessen and probably Thüringen, Belgium (Namur), Hungary (Budapest region), North Macedonia, the Crimea and possibly Georgia (Adjara). See below for detailed discussion.

Figures 1, 2. *Stigmella torminalis*, adults from Germany, Volkmarsen-Hörle. **1.** Live male, emerged 1 May 2022; **2.** Set female, emerged 1 May 2022, RMH.INS.1557369. Photographs D. Robrecht.

Hostplant. *Stigmella torminalis* has only been found on *Torminalis glaberrima* (Rosaceae). Records on other hosts must be regarded as erroneous, or refer to misidentified *S. mespilicola*.

Life history. Larvae were found in late June and July in England, Germany and Hungary, between 17 July and 4 August in the Crimea. Vacated leafmines can still be found later. Univoltine, all adults emerged (in captivity) after hibernation the next spring, in May and June. There are no records of adults caught in nature.

DNA barcoding (Fig. 53). We obtained three DNA barcodes from the Hessen material: one larva and two adults, and one from a larva from Belgium. All share the barcode, with the Barcode Identification Number (BIN) BOLD:AEO3975, the German specimens have an identical barcode, the Belgium specimen has a distance of 0.33%. The nearest neighbour is *Stigmella aurora*, BIN BOLD:AEY8102, a population from *Mespilus germanica* L. in Russia, Dagestan, at a distance of 3.5%.

Material examined. Adults. – GERMANY • 2 ♂, 3 ♀ (Figs 1–4); Hessen, Volkmarschen-Hörle, NSG Iberg; 51.44411°N, 9.0887°E; alt. 290 m; 03 Jul. 2021; D. Robrecht leg.; Host: *Torminalis glaberrima*; emerged 01–02 May 2022; Genitalia slides: EvN5447 ♂ (Fig. 12), EvN5448 ♀ (Fig. 17); RMNH.INS.25447, RMNH.INS.25448, RMNH.INS.1557369, RMNH.INS.1557289, RMNH.INS.1557370; RMNH. • 1 ♂ 2 unsexed; Same collecting data as for preceding, emerged 03 May. 2022 ; Genitalia slide: Robrecht J26 (Fig. 11); coll. W. Wittland. • 10 ♂, 6 ♀, 2 unsexed; unlabelled, almost certainly Eppelsheim material; [Rheinland-Pfalz, Grünstadt]; [49.5667°N, 8.1681°E]; [no date, 19th century]; [Eppelsheim leg.]; Genitalia slides: VU0328 (Fig. 13), VU0333, VU0334 (Fig. 14), VU0349, VU0357, VU1480 (Figs 15, 16), VU2366, VU2367; RMNH.INS.20328, RMNH.INS.20333, RMNH.INS.20334, RMNH.INS.20349, RMNH.INS.20357, RMNH.INS.21480, RMNH.INS.22366, RMNH.INS.22367, RMNH.INS.1556801– RMNH.INS.1556809, RMNH.

Leafmines and larvae. (Host always *Torminalis glaberrima*, collection RMNH). – BELGIUM • 1 dead larva, 2 mines; Namur, Rochefort, Lavaux-Sainte-Anne, Le Gros Tienne; 50.1064°N, 5.1003°E; alt. 225 m; 06 Sep. 2014; S. Wullaert leg.; EventId: Wullaert 276, 281; RMNH.INS.31737 (larva) (Fig. 23), RMNH.INS.39245. – GEORGIA • 3 vacated mines; Adjara AR, Chikuneti; 41.57028°N, 41.86278°E; alt. 880 m; 26 Sep. 2018; M.V. Kozlov & V. Zverev leg.; EventId: Kozlov-Georgia-2018–61; RMNH.INS.48100, RMNH.INS.48101. – GERMANY • 1 larva, 1 mine; Hessen, Volkmarsen-Hörle, NSG Iberg; 51.44411°N, 9.0887°E; alt. 290 m; 03 Jul. 2021; D. Robrecht leg.; slide: RMNH.INS.31632.P; RMNH.INS.31632 (barcoded larva), RMNH.INS.39228 (leafmine). • 22 mines, 13 larvae reared (Figs 18–22); same locality data as previous, 3 + 10 Jul. 2021, D. Robrecht leg.; collection D. Robrecht. – NORTH MACEDONIA • 1 vacated mine (Figs 24, 25); Ohrid, Galičica NP, N Part, NE of Velestovo, trail; 41.09655°N, 20.84073°E; alt. 1215 m; 04 Aug. 2021; E.J. van Nieukerken leg.; EventId: EvN no 2021098-H; RMNH.INS.48654.

Photographs examined. (Host always *Torminalis glaberrima*).

Adults. – HUNGARY • 1 ♀, 1 unsexed; Budapest, Hármashatárhegy; [47.556°N, 19°E]; [alt. 460–490 m]; 22 Jul. 1964; J. Szőcs leg.; emerged 19 Apr. & 04 Mar. 1965; EventId: Zucht: 36/64; HNHM. • 2 ♀ (Fig. 5); Budapest, Normafa; [47.504°N, 18.965°E]; J. Szőcs leg.; emerged 6 & 12 Apr. 1959; Genitalia slide: Tokár No. 9388; HNHM.

Leafmines and larvae. – BELGIUM • 3 mines; Namur, Rochefort, Le Gros Tienne; 50.106°N, 5.098°E; 02 Aug. 2020; Regis Nossent leg., Maarten Vangansbeke leg; https://waarnemingen.be/observation/197785811/, https://waarnemingen.be/observation/197890785/. • 1 mine; same locality data; 04 Jul. 2023; Daan Dekeukeleire leg.; https://waarnemingen.be/observation/279601319/. • 1 mine; same locality data; 30 Jun. 2024; cocoon on 6 Jul.; T. Muus leg. et coll. – GERMANY • 5 larvae; Hessen, KB Volkmarsen – NSG Iberg bei Hörle; 51.446°N, 9.089°E; 26 Jun. & 07 Jul. 2022; Hubertus Trilling leg.; https://observation.org/observation/246938772/, https://observation.org/observation/248264022/. • 1 mine; Rheinland-Pfalz, BIT Hüttingen an der Kyll; 49.96084°N, 6.59469°E; 26 Aug. 2023; Alexander Franzen leg.; https://observation.org/observation/285967244/. • 1 larva; Rheinland-Pfalz, COC Klotten Dortebachtal; 50.17072°N, 7.21337°E; 23 Jul.

2022; Rijmenans Gilbert leg.; https://observation.org/observation/250303797/. • 1 mines; Rheinland-Pfalz, WIL Erden; 49.98456°N, 7.02022°E; 27 Aug. 2023; Justus Vogel leg.; https://observation.org/observation/288321758/. – HUNGARY • 2 mines on 1 leaf [Herbarium sheet] (Fig. 30); Budapest, Hármashatárhegy; [47.556°N, 19°E]; alt. 460–490 m; 27 Jul. 1963; J. Szőcs leg.; *Torminalis glaberrima*; HNHM. • 11 mines on 7 leaves [Herbarium sheet]; same locality data; 22 Jul. 1964; J. Szőcs leg.; *Torminalis glaberrima*; EventId: Zucht: 36/64; HNHM.

The British type locality. John H. Wood (1841–1914) submitted his description of *Nepticula torminalis* on July 10th, 1890 (Wood 1890) (published in August), and as he described the moths and mines, he must have found the mines with larvae in 1889 or before. The lectotype, originating from the Stainton collection, carries a label in Stainton's handwriting with the same date, suggesting that the moth emerged on 10 July. This seems unlikely as Wood clearly stated that the species is univoltine, with mines occurring in July, while Tutt (1899) wrote that moths emerged in May-June. Three other specimens in the NHMUK collection, original from the Walsingham collection and with the handwriting of Durrant (numbers BMNH (E) 1925640–1925642), carry a written date that could be read as "10.xi.1890". We think that these dates are wrong transcriptions from Wood's original data, most likely of 10.vi.1890. These labels also mysteriously cite the locality as "Tarrington, BEDFORD, E." whereas it should be Tarrington, Hereford (the county of Bedfordshire is ca 100 km to the east).

Wood's collection ended up in the NHMUK (Edwards 1926; Chandler 2014), and at least the Diptera in it were mounted by three on discs of card, with labelling on the underside of the disc (Chandler 2014). There are at least 12 other specimens of *Stigmella torminalis* in NHMUK from his collection, but all without dates (Schoorl et al. 1985). Wood found the larvae in July (presumably thus in 1889) in a wood near his home in Tarrington (Herefordshire, coordinates of the village 52.063, -2.559), as he wrote: "*Although its foodplant grows here more or less plentifully in all the woods, I can only find the insect in one small corner of one of them. In this very limited spot it is fairly common, nearly every bush having a few tenanted leaves, with occasionally two or even three mines in a leaf*".

Later he specified the locality as Stoke Wood (Wood 1908), written by Roper (1993) as Stoke Edith Wood. The old Ordnance Survey maps (https://maps.nls.uk/geo/explore/side-by-side/#zoom=14.9&lat=52.05488&lon=-2.57673&layers=6&right=OSAPI) do not cite this exact name, but "Stoke Edith Park", which seems less likely to be the exact locality, being a more open parkland, whereas a bit south is a large woodland, named either "the Plantation" or "Dormington Wood" on most maps. This is a little over 1 km southwest of Tarrington. According to Roper (1993) this area, the Malvern and Suckley Hills, is one of the strongholds of the Wild Service tree in Britain, where the tree reaches one of its highest densities. Other records in local publications of *S. torminalis* in our opinion all point back to the original record (Hutchinson 1892; Wood 1894, 1908).

Wood apparently reared a considerable number of adults and distributed them freely amongst several collectors. The species was described and mentioned in all major British handbooks (Meyrick 1895; Tutt 1899; Meyrick 1928; Emmet 1976), and the male genitalia were illustrated by Beirne (1945), and male and female genitalia together with a full redescription later in the revision of the *Stigmella oxyacanthella* group (Schoorl et al. 1985), but it was never recorded again and Davis (2012) considered it to be extinct.

There have been a few later British records of leafmines, but they are probably completely wrong, such as Trebilcock (1965: 123), who cites it from Cornwall, noting that the larva was raised from cultivated cherry near Bodmin, which is an incorrect hostplant. Emmet (1973) suggested that

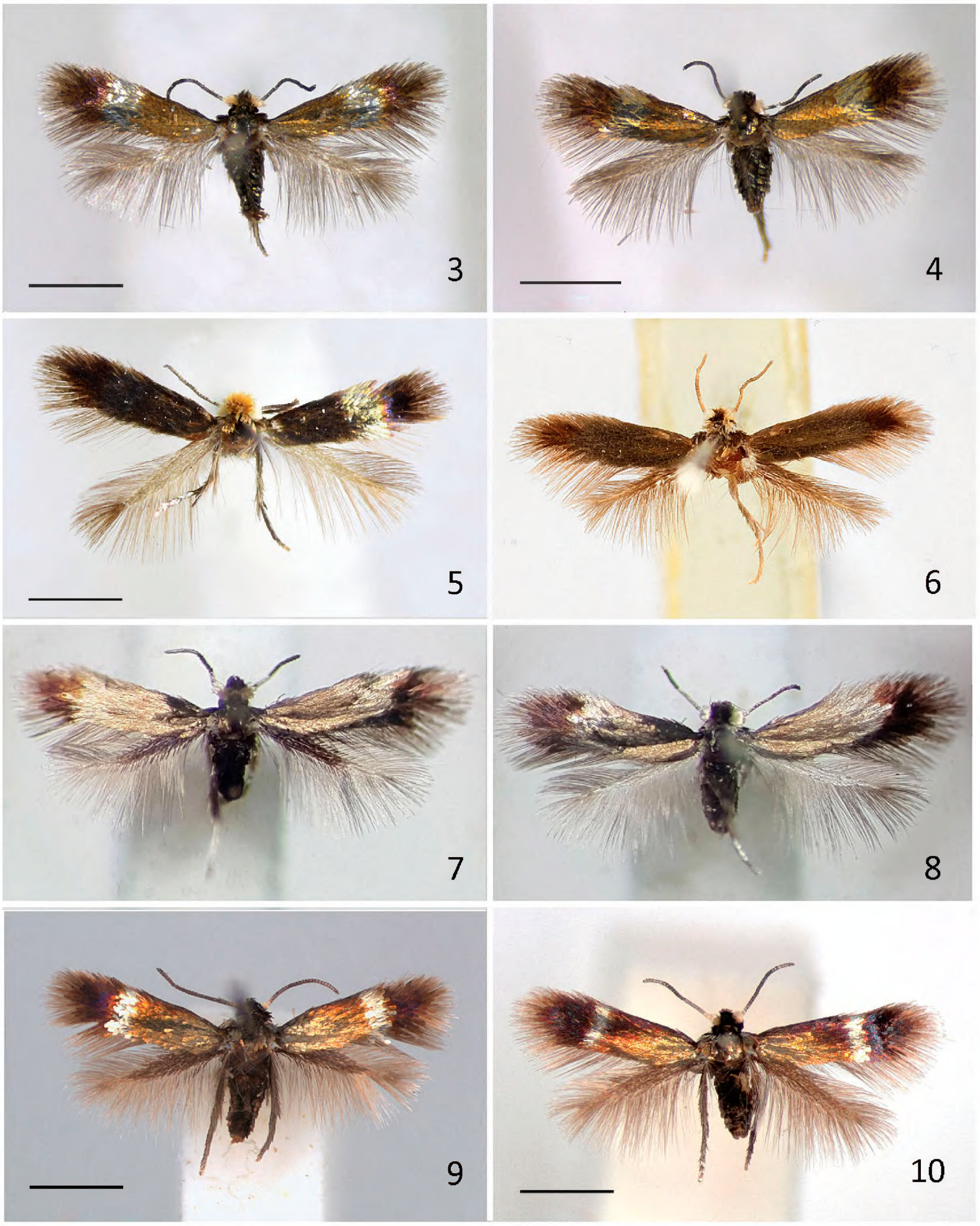
the leafmine on *Torminalis* that Bradford (1973) exhibited might be that species, but he probably later reconsidered that as he wrote: *We must try to rediscover torminalis. It was recorded only by Wood, who stated that it was "confined to a small corner of one wood" at Tarrington in Herefordshire* (Emmet 1974). The mines that were recorded later from this host all belong to *Stigmella mespilicola* (Emmet 1988; Agassiz 1992; Edmunds 2024).

The old German localities. The first record of *Stigmella torminalis* in Germany that we could trace was in the handbook by Hering (1932: 7), who recorded *Nepticula torminalis* from "Westdeutschland, selten". It is possible that Hering actually had seen moths from the Staudinger collection, as he was based in Berlin, but we have no proof that his record was correct, but see below. Real proof that *S. torminalis* occurred in West Germany, only came with the revision by Schoorl et al. (1985), who cited specimens from respectively "Donnersberg" and "Rheinland-Pfalz", Staudinger (NHMUK), Pfalz, leg. Eppelsheim (MHUB) and unlabelled ones from the Amsterdam and Leiden collections (ZMAN and RMNH, now all in RMNH, see material examined). All these specimens and several others seen later in other European museums looked similar with respect to pins and pith, and sometimes carried labels, often not, and were often placed under various other species. The material from the Bentinck collection in RMNH e.g., was partly misidentified as *S. lonicerarum* (Frey, 1857), partly as *S. aceris* (Frey, 1857). This suggested that they were once obtained from the insect selling company Staudinger and Bang Haas, maybe partly without species name, and probably all go back to the same reared series. An early indication of this is the first illustration of the male genitalia, misidentified as *Nepticula mespilicola* by Petersen (1930: fig. 55, page 59), originating from Pfalz. He also quotes Hering: "according to M. Hering is *mespilicola* = *torminalis*". Petersen used the Berlin collection with Staudinger material as source for the genitalia dissections. Another indication is the more detailed illustration of the male and female genitalia by Puplesis in Ivinskis et al. (1985: 217) under *S. mespilicola*, specimens in the collection of the Zoological Institute in St. Petersburg, that also came from Rheinpfalz, [18]97, Staudinger (Johansson and Nielsen 1990).

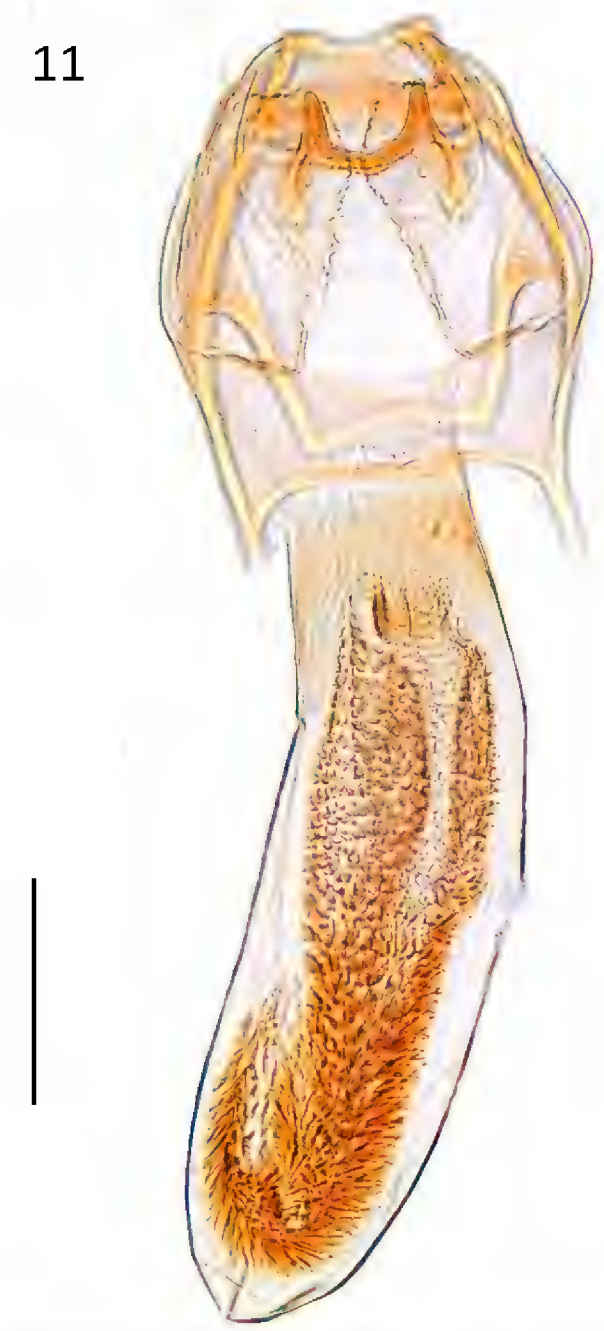
Donnersberg (49.62, 7.91) is a forested mountain ca 20 km west of Grünstadt (49.56, 8.17) in Pfalz. Friedrich Eppelsheim (1834–1900) lived in Grünstadt and collected especially Microlepidoptera in that region, but rarely published about those (E. Hering 1900). Disqué (1902: 226) wrote about him:

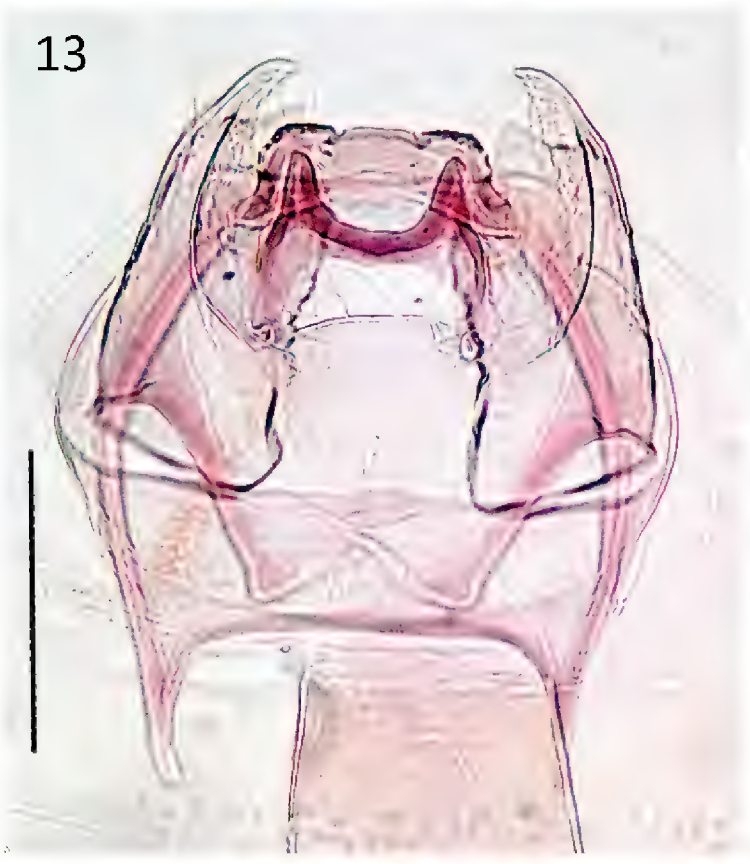
„Vorstehender Gattung [= Nepticula] *habe ich bis jetzt noch wenig Aufmerksamkeit geschenkt: doch besitze ich fast alle in der Pfalz vorkommenden Arten durch die Güte des verstorbenen Herrn Oberamtsrichters Eppelsheim in Grünstadt, der sich in den letzten Jahren seines Lebens fast ausschliesslich der Zucht dieser Kleinsten der Kleinen widmete. Zweifellos kommt die grössere Zahl der in der Pfalz vorkommenden Arten auch in hiesiger Gegend vor. [So far I have paid little attention to this genus* [= Nepticula]*, but I have almost all the species occurring in the Palatinate through the kindness of the late Chief magistrate Eppelsheim in Grünstadt, who devoted the last years of his life almost exclusively to the breeding of these smallest of the small. There is no doubt that the majority of the species found in the Palatinate also occur in this region]"*

The records of *S. torminalis* are probably hidden under those of *Nepticula mespilicola* in the second list of Pfalz Microlepidoptera (Disqué 1907: 95) as "Mespilicola Frey. R. Amelanchier. Sorbus." Griebel (1911: 103) reported in more detail about this species: "Bei Grünstadt, Eisenberg und am Donnersberg. Die Raupe an *Amelanchier vulgaris*, *Sorbus Aria* und *torminalis*." "[Near Grünstadt, Eisenberg and on the Donnersberg. The caterpillar on *Amelanchier vulgaris*, *Sorbus Aria* and *torminalis*.]".



Figures 3–10. *Stigmella* species, adults. **3, 4.** *S. torminalis*, Germany, Volkmarsen-Hörle, resp. male, RMNH.INS.1557370 and female RMNH.INS.25448; **5.** *S. torminalis*, red headed female, Hungary, Normafa, genitalia slide Z. Tokar 9388; **6.** *S. hahniella*, male Lectotype; **7.** *S. hahniella*, male, Moravia, Prostejov, ex l. iii.2001; **8.** *S. hahniella*, female, Milovice, ex l., iii.2001; **9.** *S. mespilicola*, male, Italy, Noli, reared from *Cormus domestica*, RMNH.INS.24240; **10.** *S. mespilicola*, male, France, Fessenheim, reared from *Torminalis glaberrima*, RMNH.INS.1556810. Scale lines: 1 mm. Photographs E.J. van Nieukerken, Anna Somogyi (Fig. 5), SMNS (Fig. 6), A. Laštůvka (Figs 7, 8).



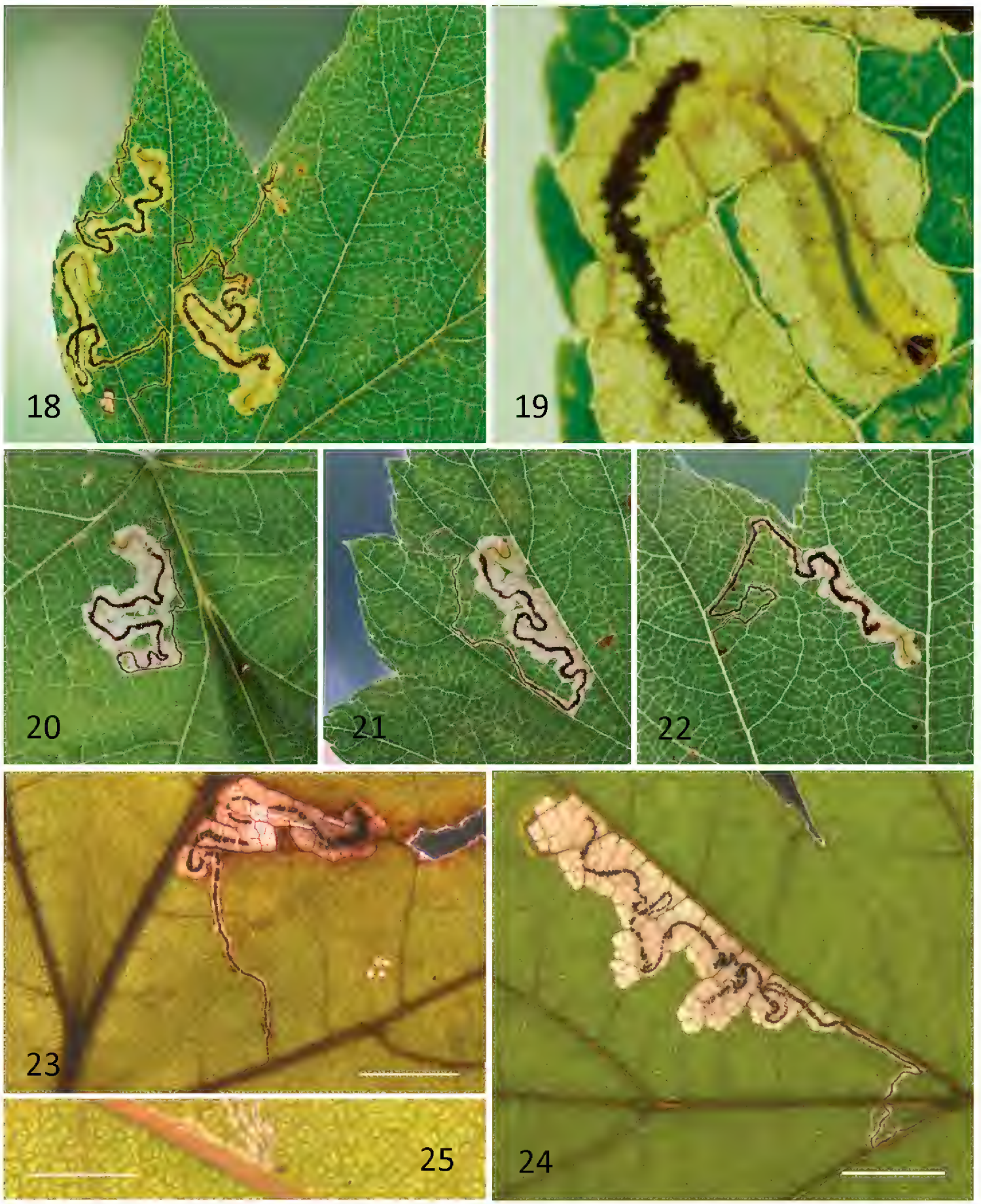


Figures 11–14. *Stigmella torminalis*, male genitalia, ventral aspect. **11.** Slide J26; **12.** Slide EvN5447, vesica everted; **13.** Slide VU0328; **14.** Slide VU0334. Scale lines: 100 µm.

Figures 15–17. *Stigmella torminalis*, female genitalia, dorsal aspect. **15, 16.** Slide VU1480, 16 detail of terminal segments; **17.** Slide EvN5448, detail of accessory sac. Scale lines: 200 µm (**15**); 100 µm.

Together with the cited specimens one may conclude that Eppelsheim collected this species at least in Grünstadt and Donnersberg on *Torminalis*, and also collected *S. mespilicola* on the three hosts. As in England, the species must have been common in this area at the end of the 19th century.

The new German records. The second author found 13 larvae on *Torminalis glaberrima* in Hessen, Volkmarsen-Hörle, NSG Iberg, elevation 280 m, on July 3rd, 2021, some mines were already vacated. On July 10th, 2021 one larva and six vacated mines could be found. One larva was found on June 26th, 2022 and four larvae on July 7th 2022. The identification was confirmed by the senior author by DNA barcoding of a larva, and later by the emerging adults. After spreading the word to some local collectors by DR, a few more records of mines were made in Rheinland-Pfalz in 2022 and 2023 (all checked by DR, listed by Robrecht et al. 2024), and we spotted one record from Klotten on Observation.org, then misidentified as *Stigmella magdalenae* (Klimesch, 1950) (https://observation.org/observation/250303797/).



Figures 18–25. *Stigmella torminalis*, leafmines on *Torminalis glaberrima*. **18–22.** Germany, Volkmarsen-Hörle, mines with larvae, 3.vii.2021; **23.** Belgium, Lavaux-Sainte-Anne, mine with dead barcoded larva, RMNH.INS.31737; **24, 25.** North Macedonia, Galičica NP, vacated mine and egg on leaf underside, RMNH.INS.48654. Photographs D. Robrecht (18–22), E.J. van Nieukerken (23–25).

The NSG Iberg is a limestone slope exposed to the west. In the forest area grow mainly beech (*Fagus sylvatica* L.), Scottish pine (*Pinus sylvestris* L.), larch (*Larix decidua* Mill.), sycamore (*Acer pseudoplatanus* L.), hawthorn (*Crataegus* Tourn. ex L.) and sloe (*Prunus spinosa* L.) trees. There are about 20 adolescent *Torminalis glaberrima* trees which are heavily shaded (Fig. 26).

Figure 26. *Stigmella torminalis*, habitat in Volkmarsen-Hörle. Photo H. Trilling.

Other new records. We record the species here new for North Macedonia (Galičica National Park, N. part) on the basis of a single vacated leafmine (Figs 24, 25) and from Belgium (Namur: Rochefort), based on leafmines with dead larvae, one of which was barcoded (Fig. 23), and additional observations from the same localities on the observation site https://waarnemingen.be/ and one larva in 2024 (T. Muus leg.). Three leafmines from Georgia (Adjara) are tentatively also regarded as *S. torminalis*, although they were collected late September, it is possible that larvae occur slightly later in the Caucasus and that the vacated mines lasted several weeks after larval occurrence.

Discussion of literature records. Germany. The oldest record maybe that by Martini (1917: 179), who recorded *Nepticula mespilicola* from Sachsenburg (Thüringen, 51.29,11.16), from caterpillars on *Sorbus torminalis* in July, and reared moths in the following April. This would indicate a univoltine species, and is thus more likely *S. torminalis* than *S. mespilicola*.

After M. Hering's (1932) first record of the adult, that was repeated by Eckstein (1933: 199) in his handbook for Microlepidoptera, Hering described also the leafmines and compared them with those of *S. mespilicola* in his first leafmine key work (M. Hering 1937), then still under a large genus *Pyrus* L., then including *Malus* Mill. and *Sorbus* L. This key has probably been a major source for the later confusion with *S. mespilicola*, as he separated the mines only by the width of the frass line (page 377). He also listed both "*P. aria*" and "*P. torminalis*" as hosts. In his later keys for Europe (M. Hering 1957), he maintained that key character, and even included *Sorbus aucuparia* (page 1012) and *Amelanchier* Medik. (page 77) as hosts. He did, however, mention only the month July for the occurrence of the mines, whereas he recorded those of *S. mespilicola* (as *S. ariella* (Herrich-Schäffer, 1860)) from July, September and October.

Figure 27. Distribution records of *Stigmella torminalis*, mapped on the distribution area of *Torminalis glaberrima* (solid green). Extinct in Great Britain.

Many of the subsequent records can easily be dismissed on the basis of their occurrence in the autumn, on the wrong hosts or because adults were reared in summer. As none of the other published German records have been provided with more detail or illustrations of either the adult, genitalia or leafmine, we consider them all as incorrect or at least unverified, until proof can be obtained from collection material.

The next record was from Württemberg by Wörz (1937: 290), when he described the new species *Nepticula hahniella*. He also gave a key with some more characters, such as the egg position, and larval colour, but both are confusing as the egg position is variable in *S. mespilicola* and the larva of that species is not green, but yellow. The senior author examined the leafmines (Figs 28, 29) and adults in Wörz's collection in Stuttgart, and concluded that all mines and adults identified as *S. torminalis* are misidentified *S. mespilicola* (the adults had earlier also been re-identified by A. Laštůvka). The incorrect Württemberg records were repeated several times (Skala 1939; Wörz 1958).

Ludwig (1952: 33) recorded *S. torminalis* from Nordrhein-Westfalen, Siegen from leafmines on *Sorbus aucuparia*, which must be regarded as certainly wrong. Such mines most likely belong to *S. magdalenae* (Klimesch, 1950).

In Bavaria (Bayern) the species was recorded from leafmines on *Torminalis* by Huber (1969: 98) from two localities in Schwaben. As no details are given, this cannot be proven. This record was repeated in some checklists (Pröse 1987; Pröse and Segerer 1999), but finally deleted from the fauna (Haslberger and Segerer 2016).

Figures 28–31. Herbarium sheets with leafmines on *Torminalis glaberrima*, originally identified as *Stigmella torminalis*. **28, 29.** Collection Wörz (SMNK), Feuerbach-Lemberg: misidentified, all mines belong to *S. mespilicola*; **30.** Collection Szőcs (HMHN), correctly identified. The Hungarian text reads: "*Budapest Hármashatárhegy, 1964.VII.22. leg Szőcs J., Zucht 36/64, h[ernyó] fehér, feje barnás-fekete, bélsáv zöldes, v[agy] barnás, v[agy] vöröses petehéj a fonákon*". Translated (part after 36/64): "*caterpillar white, head brownish-black, intestine greenish, brownish, or reddish, eggshell at the back*"; **31.** Collection Szőcs (HMHN), Badacsony: misidentified, all mines belong to *S. mespilicola*.

Steuer (1984: 97) reported mines from Thüringen, Bad Blankenburg, in September both on *Torminalis* and *Aria edulis* (Willd.) M. Roem. A reared female was examined by EvN and belongs to *S. mespilicola*. The record was later corrected (Steuer 1991). However, as shown above, the species probably does or did occur in Thüringen.

The latest published record, also from Hessen (Hannover 2019: 39) was a vacated leafmine on *Sorbus aucuparia*, and also from September, thus certainly incorrect. Such mines could belong either to *S. magdalenae* or *S. nylandriella* (Tengström, 1848).

The record by Biesenbaum (2006: 49) from the Eifel was not a misidentification, but a corruption for *S. tormentillella* (Herrich-Schäffer, 1860), see Biesenbaum (2007) [where the incorrect spelling *S. "tormetillella"* was used]. This was repeated by Gaedike (2008: 13) and corrected later (Gaedike 2009).

Switzerland. Weber (1945: 401) recorded *S. torminalis* from Altberg near Weiningen, mines with larvae in August and October both on *Aria edulis* and *Torminalis*. The timing already makes this *S. mespilicola* and a photo of the reared specimen in the ETZ collection (courtesy Andreas Kopp, see under material of *mespilicola*) confirms that. The inclusion in the Swiss checklist is therefore incorrect (SwissLepTeam 2010) and it was recently deleted (Bryner and Kopp 2023).

Austria. Klimesch and Skala (1936: 95) recorded leaf mines from Maria Winkling, already including some doubts, and this was later corrected to *S. mespilicola* (see Klimesch 1990: 33), but still with a note that the identification was not certain. Skala (1937: 10) recorded one mine from Wien-Schönbrunn on 30 September 1935 and later (Skala 1944b: 393) on 11 September on *Aria edulis*. Both clearly belong to *S. mespilicola*, which also was suggested by Skala in his last paper. He then also noted: "Die Mine der torminalis Wood scheint unbekannt zu sein". Also Zimmermann (1944) recorded it from the Vienna region: Schönbrunn and Wien-Bèlvedere, mines on *Torminalis* and ? *Aria*. Huemer and Tarmann (1993) did not accept these records and deleted the species from the Austrian list.

Czechia. Skala (1944a: 115) reported "*Nepticula torminalis* Wood im Sinne Herings" from Eisgrub (= Lednice) in October and Tischnowitz (=Tišnov) in August. He added that he considered it as a form of *S. mespilicola* and that is most likely the correct identification of these records. Zimmermann (1944) repeated the Eisgrub record. Laštůvka et al. (1993) excluded these records and thus the species from the Moravian and the Czech fauna.

Hungary. The species was repeatedly recorded from Hungary, from Nadap, Budakeszi, several localities near Budapest (Szőcs 1956, 1965, 1977a, 1981b), the Mecsek mountains (Balogh 1978) and Badacsony, Uzsa (Szabóky 1982). Probably many of these records are incorrect, several have the wrong timing or hostplant. Already in 1981, EvN studied a borrowed pair of moths of *S. torminalis* from the Szőcs collection (from Budapest, Normafa, see below), which turned out to be *S. mespilicola* (genitalia slides VU1755 and VU1756). These were collected in June as larva and emerged already in July. On this basis EvN considered at the time all records of *S. torminalis* in Hungary as incorrect or unproven. In the draft of the European list (van Nieukerken 1996) he did not enter Hungary in the country list, but this was added later by a country recorder without EvN's knowledge. Also Fazekas (2007: 17) concluded that Balogh's record was unconfirmed on the advice of EvN. Finally Pastoralis (2010) removed the species from the Hungarian list, based on advise of Zdenko Tokár who had the opportunity to check one specimen.

However, the situation is clearly more complicated, as Szőcs (1981b) collected larvae only in June and July, and reared adults from some of those in the early months of the next year. This would point to the univoltine *Stigmella torminalis*. As Z. Tokár (pers. comm.) had identified the above cited specimen as *S. regiella* (Herrich-Schäffer, 1855) (based on externals), not the more obvious alternative *S. mespilicola*, we wondered if this could be a *S. torminalis* with red head

rather than brown or black, as otherwise the externals of *S. regiella* and *S. torminalis* are very similar. On EvN's request, Z. Bálint (Budapest) sent a couple of photos of adults and leafmines. He also arranged photograps of the genitalia prepared by Tokár after remounting it on slide. After carefully studying the photos of the leafmines (e.g. Fig. 30) and the adults (Fig. 5), we conclude that a few specimens that were reared in spring from larvae collected in the previous June or July belong to *S. torminalis*, even though some specimens have an orange head, whereas the majority of leafmines and adults belong to *S. mespilicola*. The mines from the sample with orange heads (Hármashatárhegy, 22.vii.1964, Zucht 36/74, see Fig. 30) clearly show the characters of *S. torminalis*, not *S. regiella*, and one adult from that sample has a dark head. Finally the photo of the genitalia showed a round accessory sac, typical for *S. torminalis*. The *S. torminalis* specimens were from two localities, Budapest, Hármashatárhegy and Budapest, Normafa.

Italy. There are two potentially wrong records: Klimesch (1940: 189) recorded it from Trieste on the basis of two vacated mines on *Torminalis* in October and later he found a single mine in Sopra Sasso in late September (Klimesch 1951: 58). The dates speak for identification as *S. mespilicola* and it was therefore not included in the Italian checklist (Karsholt et al. 1995).

Slovenia. Jože Maček recorded *S. torminalis* three times (Maček 1970, 1979, 1993), summarised again by Maček (1999). Two records are wrong on the basis of the hostplants *Amelanchier ovalis* Medik. and *Aria edulis*, the one recorded from *Torminalis* was found in September, the wrong period for the mines (although it might be possible to find old mines). All these should be regarded most likely as *S. mespilicola*. Maček based his identifications and taxonomy largely on Hering, inclusion of *S. torminalis* in the Slovenian checklists is therefore incorrect (Lesar and Habeler 2005; Lesar and Govedic 2010).

Serbia. Jakšić (2016) listed *S. torminalis* on the basis of four papers by Nenad Dimić. Three of these papers were examined by us (Dimić 1994; Dimić et al. 1999, 2000) and show no detail about collection dates or hostplants and are based on leafmines alone, identified with Hering's keys. Also the used nomenclature is completely out of date, providing little trust that these records are reliable. For now *S. torminalis* should be deleted from the Serbian fauna.

Romania. Drăghia (1976: 180) reported it from *Torminalis* in the northern Dobrogea area in 1973 and 1974, without further details. Although it is possible that some of these were correct, considering the occurrence of *Stigmella torminalis* on the Crimea, without voucher material the record cannot be accepted. It was also entered in the checklist by Popescu-Gorj (1984), but Rákosy et al. (2003) stated that the record requires confirmation.

Ukraine, Crimea. Navickaitė et al. (2014) recorded *S. torminalis* as new from the Crimea, as very common in a few localities, from adults reared from larvae that were collected in July-August 2011. This record is amply annotated with photos of larvae, leafmines and genitalia, and definitely correct.

Stigmella hahniella (Wörz, 1937)

Figs 6–8, 32–41

Nepticula hahniella Wörz, 1937: 290. Lectotype ♂ (designated by Schoorl et al. 1985: 80). **Germany**, Württemberg, Lemberg bei Zuffenhausen, 17 u 25.7.[19]36, Sorbus torm., Wörz. Genitalia slide ♂ VU no. 0434, SMNS – Lepid. Präparat-Nr. 215 Eup. (SMNS). Pinned with female paralectotype and 2 cocoons on same piece of polyporus (Fig. 6).

Stigmella hahniella (Wörz, 1937) Gerasimov 1952: 241. New combination.

Stigmella hahniella; important citations: Schoorl et al. 1985; Johansson and Nielsen 1990; Puplesis and Schoorl 1994; Laštůvka and Laštůvka 1997; Navickaitė et al. 2014; Robrecht et al. 2024.

Recognition. Adult (Figs 6–8) (based on earlier descriptions (Schoorl et al. 1985; Johansson and Nielsen 1990). Wingspan ♂ 3.5–4.1 mm, ♀ 3.5–4.0 mm. Antennae ♂ with 19–23 articles, ♀ with 17. Moth characterised by black frontal tuft, white collar; forewings proximal two-thirds or three-quarters bronze brown, sometimes with faint purple tinge; apical third or quarter dark brown with faint purple tinge; demarcation between basal and apical colours sharply or weakly defined; hindwing in male with dark androconial scales at costa and dorsum. Could be confused with other dark winged *Stigmella* species, but sharp demarcation on forewing usually diagnostic; only black headed *S. anomalella* (Goeze, 1783) look rather similar.

Male and female genitalia resemble closely those of *Stigmella crataegella* (Klimesch, 1936), see diagnosis and illustrations in Johansson and Nielsen (1990), Schoorl et al. (1985) and photos in Navickaitė et al. (2014).

Leafmines (Figs 32–39). Egg always on leaf underside close to midrib or another main vein. Mine starts often very contorted, but also regularly as a rather straight gallery; frass completely brown or green, coiled throughout, filling mine completely or leaving narrow margins in latter part of mine.

Larva: green, head capsule and thorax pale, larva with dorsum upwards.

Cocoon: pale brown.

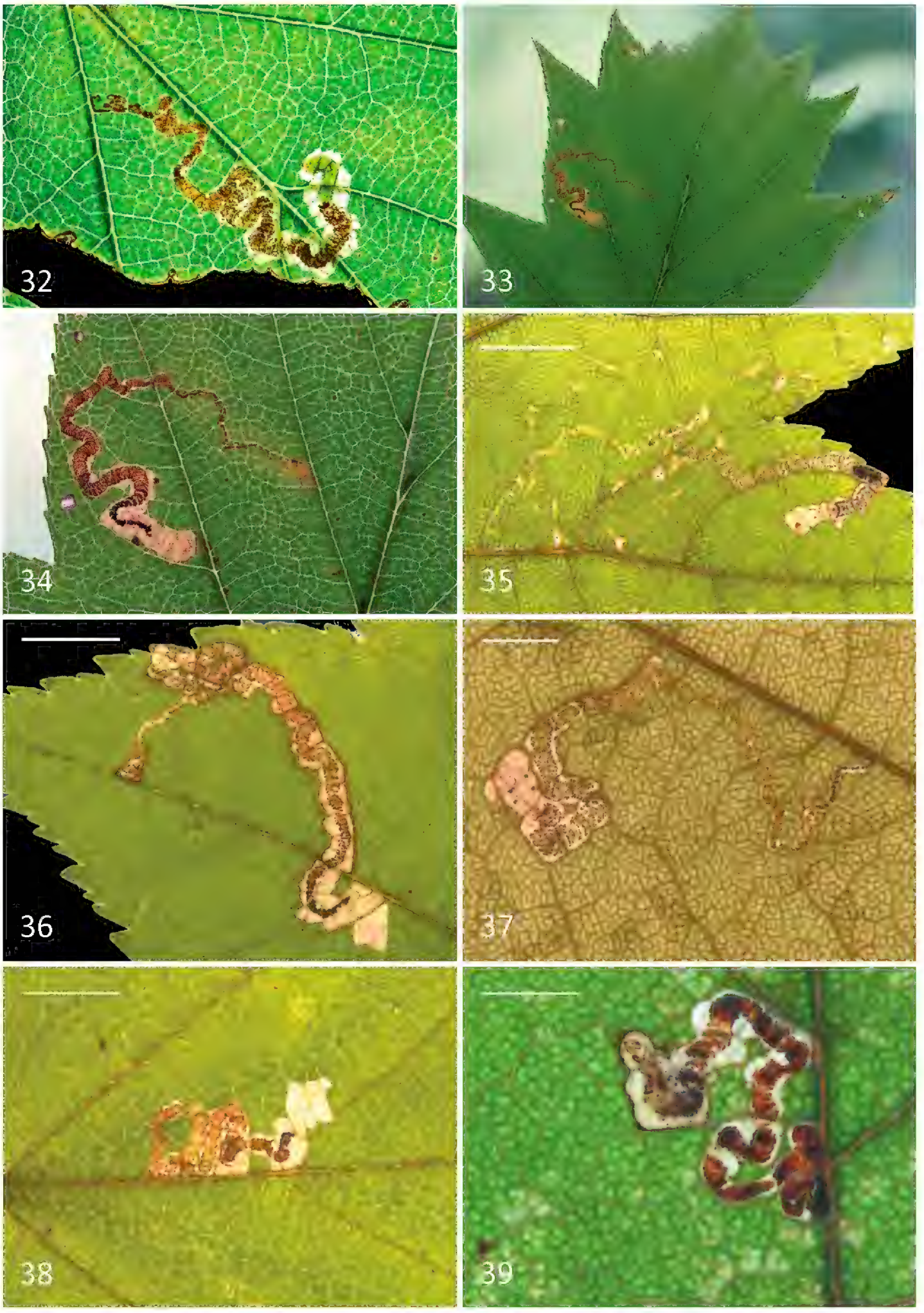
Distribution (Fig. 41). Austria* (Zimmermann 1944; Huemer 2013), Bosnia* (new record) (Fig. 37), Croatia (Laštůvka and Laštůvka 1997), Czechia (Laštůvka 1994; Laštůvka and Marek 2002; Šumpich 2011), France* (new record) (Figs 36, 38), Georgia (new record) (Fig. 39), Germany (Wörz 1937; Buhr 1940; Huber 1969; Robrecht et al. 2024), Hungary (Szőcs 1965, 1977b; Pastoralis and Szeőke 2011), Italy (Huemer 2002), Russia* (Wörz 1937), Slovakia (Povolný and Gregor 1952; Patočka and Kulfan 2009), Slovenia* (Lesar and Govedic 2010), Ukraine: Crimea (Navickaitė et al. 2014). Records based on mines only are annotated with an asterisk.

Several records were doubted in the past, such as those from Germany: Schwaben (Bavaria) (Huber 1969) and Austria (Zimmermann 1944), leading to removal of the species resp. from the Bavarian and Austrian lists (Huemer and Tarmann 1993; Haslberger and Segerer 2016). The Austrian record was later confirmed (Huemer 2013), and we think that Huber's record is rather likely, considering the current knowledge of its distribution.

The old records from Pfalz and Thüringen by Wörz (1937) also could well be correct as also the new records show. An old record from Neubrandenburg in Mecklenburg-Vorpommern (Buhr 1940) has been completely overlooked until now, and on first sight might seem unlikely, so far north. However, *Torminalis* does occur in this region, but probably as rather isolated trees (Welk et al. 2016). Confirmation of this record is therefore needed as it is not impossible that *Stigmella oxyacanthella* (Stainton, 1854) could occasionally occur on this host and make rather similar mines. The renewed search for *Stigmella torminalis* also led to the rediscovery of leafmines of *S. hahniella* in Germany in 2023, now in Rheinland-Pfalz, and independently by Maurizio König in Baden-Württemberg and Bavaria. In 2024 it was found in Hessen (Figs 33, 34, 40) and Thüringen (Fig. 32) and the species was discovered in North East France (Figs 36, 38).

The record from Russia, Sochi by Wörz (1937) was overlooked in the Russian checklist (van Nieukerken and Sinev 2019), but the new record from Georgia, confirmed by DNA barcodes, supports its occurrence in the Caucasus region.

Records from Denmark (Jøker 1944) on *Crataegus* and various *Sorbus* species are certainly incorrect and were also not repeated in the catalogue of Danish leafmines (Sønderup 1949).



Figures 32–39. *Stigmella hahniella*, leafmines on *Torminalis glaberrima*. **32.** Germany, Ochsenburg, mine with larva; **33, 34.** Germany, Diemelstadt-Rhoden, vacated mine; **35.** Germany, Schweigern, mine with dead barcoded larva, RMNH.INS.31738; **36.** France, Pagny-sur-Meuse, vacated mine, RMNH.INS.38642; **37.** Bosnia-Herzegovina, Brezičani, mine vacated by parasitoid, ZMA.INS.MIG.12042; **38.** France, Pagny-sur-Meuse, vacated mine, RMNH.INS.38642; **39.** Georgia, Chikuneti, mine with dead barcoded larva, RMNH.INS.31426. Photographs A. Franzen (**32**), D. Robrecht (**33, 34**), E.J. van Nieukerken (rest).

Figure 40. *Stigmella hahniella*, habitat in Diemelstadt-Rhoden. Photo D. Robrecht.

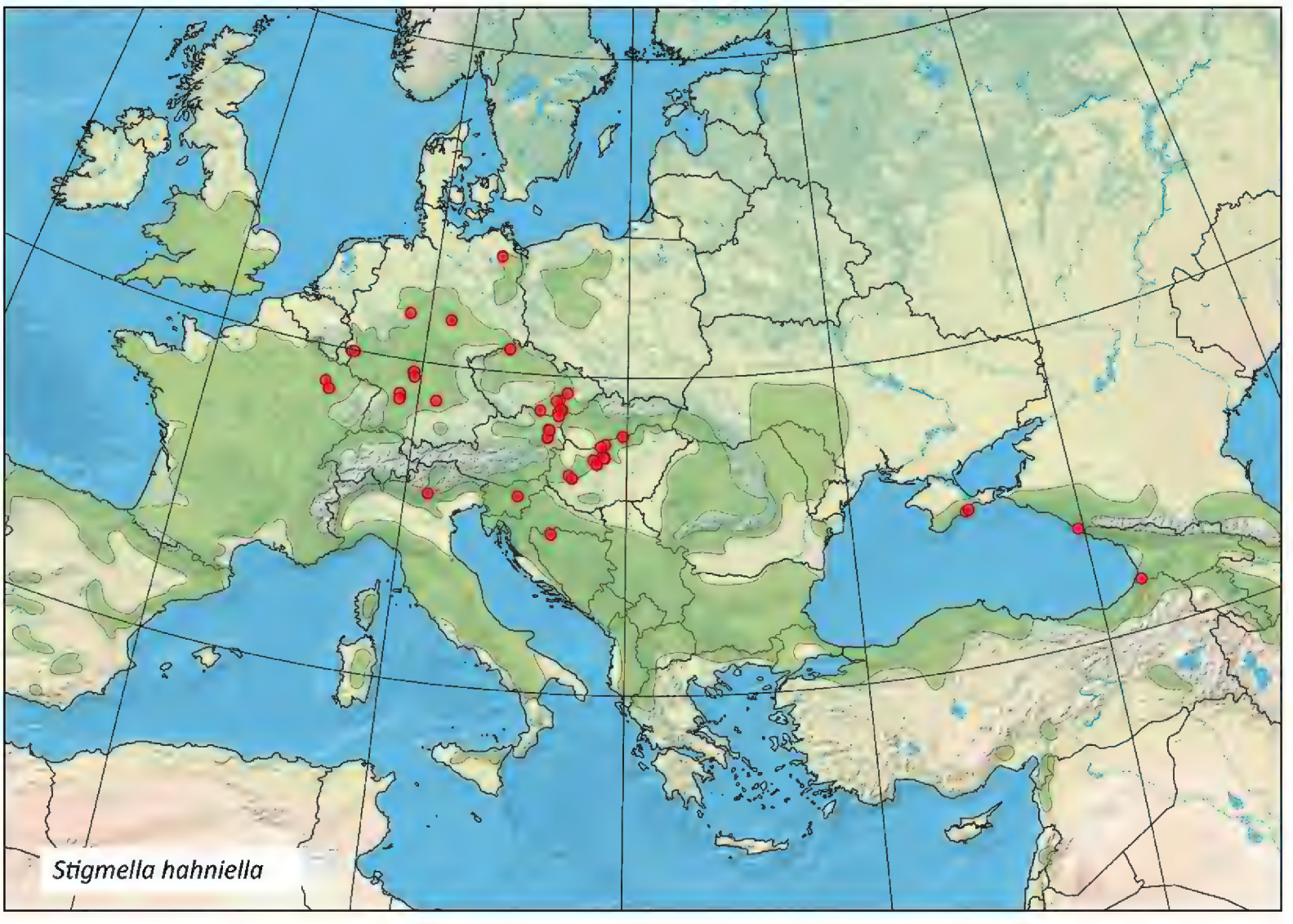


Figure 41. Distribution records of *Stigmella hahniella*, mapped on the distribution area of *Torminalis glaberrima* (solid green).

Host plant. Only known from *Torminalis glaberrima*. Szőcs (1973, 1981a) reported leafmines from *Sorbus aria* and *S. degenii* Jáv. (now respectively *Aria edulis* and *Karpatosorbus degenii* (Jáv.) Sennikov & Kurtto). As these have not been confirmed by reared adults or DNA barcoding we consider them as unlikely, or at least unproven.

Life history. Bivoltine. Larvae are found from May to June and from August to October. Adults emerged respectively from June to July, and in March (probably forced indoors). There are no records of wild caught adults, very few adults are known. Most recent records are based on vacated leafmines, with a few dead larvae (used for DNA barcoding), and only a single photo represents a living larva https://observation.org/observation/321525068/.

DNA barcoding (Fig. 53). We have four DNA barcodes, two from adults from Czechia and two from dead larvae in Germany, all belong to BIN BOLD:ADF7891, with a maximum distance of 0.8%, and average distance of 0.47%. One barcoded larva from Georgia falls in another BIN, BOLD:AEF9699, at a distance of 2.4% from the European ones.

Material examined. Adults (Host always *Torminalis glaberrima*). – GERMANY • 1 ♀ Paralectotype, pinned together with Holotype; Baden-Württemberg, Zuffenhausen, Lemberg; [48.82°N, 9.14°E]; 27 Jun. 1936; A. Wörz leg.; emerged 17–25 Jul. 1936; Genitalia slide: VU0438 | SMNS215; GART00125b; SMNK. – HUNGARY • 2 ♂; Badacsony; [46.799°N, 17.495°E]; J. Szőcs leg.; emerged 27–28 Jun. 1968; Genitalia slide: VU1757; HNHM. • 1 ♂ 1 ♀; Budaörs; [47.47°N, 18.94°E]; 12 Jun. 1974; A. Borkowski leg.; emerged 04 Jul. 1974; Genitalia slide: RJ1475; personal collection R. Johansson. • 2 ♂ 1 ♀; Budapest, Rupphegy; [47.474°N, 18.978°E]; J. Szőcs leg.; emerged 06 Jul. 1974, 26–28 Jun. 1975; Genitalia slides: VU1472, VU1477, VU1754; HNHM.

Leafmines and larvae (Host always *T. glaberrima*, coll RMNH unless otherwise mentioned). – AUSTRIA • 4 mines; Niederösterreich, Gumpoldskirchen: Glaslauterriegel; 48.0303°N, 16.2507°E; alt. 300–340 m; 01 Oct. 1983; van Nieukerken & Boomsma leg.; EventId: VU no. 83323-H; ZMA.INS.MIG.12041. • 1 mine; Wien, Leopoldsberg, W. of Kahlenberg; 48.2773°N, 16.34782°E; alt. 200–425 m; 25 Oct. 1983; E.J. van Nieukerken leg.; EventId: VU no. 83540-H; RMNH.INS.39794. – BOSNIA-HERZEGOVINA • 2 mines (Fig. 37); Republika Srpska, Brezičani, 5 km NW Prijedor; 45.014°N, 16.669°E; 17 Oct. 1983; van Nieukerken & Boomsma leg.; EventId: VU no. 83494-H; ZMA.INS.MIG.12042. – FRANCE • 1 mine; Meuse, Chauvoncourt, Pelouses et vallons forestiers de Chauvoncourt – N2000; 48.88963°N, 5.50107°E; alt. 296 m; 26 Jul. 2024; E.J. van Nieukerken leg.; EventId: EvN no 2024065–2H; RMNH.INS.38649. • 5 mines (Fig. 36); Meuse, Pagny-sur-Meuse, Chapelle de Massey; 48.66367°N, 5.7259°E; alt. 288 m; 25 Jul. 2024; E.J. van Nieukerken leg.; EventId: EvN no 2024060–1H; RMNH.INS.38641, RMNH.INS.38642. – GEORGIA • 1 larva, 3 mines (Fig. 39); Adjara AR, Chikuneti; 41.57028°N, 41.86278°E; alt. 880 m; 26 Sep. 2018; M.V. Kozlov & V. Zverev leg.; slide: RMNH.INS.31426.P; RMNH.INS.31426 (larva); RMNH.INS.48098, RMNH.INS.48099 (leafmines). – GERMANY • 1 larva, 4 mines; Baden-Württemberg, Königheim, Haigergrund; 49.63765°N, 9.57404°E; alt. 329 m; 14 Aug. 2023; Maurizio König leg.; RMNH.INS.31739 (larva), RMNH.INS.49915, RMNH.INS.49816 (leafmines). • 2 mines; Baden-Württemberg, Tauberbischofsheim, Hunsenberg; 49.64794°N, 9.63004°E; alt. 285 m; 25 Aug. 2023; Maurizio König leg.; RMNH.INS.49917. • 1 larva, 1 mine (Fig. 35); Baden-Württemberg, Schweigern; 49.49514°N, 9.66925°E; alt. 265 m; 10 Aug. 2023; Maurizio König leg.; RMNH.INS.31738 (larva), RMNH.INS.49786 (leafmine). • 3 mines (Figs 33, 34); Hessen, Diemelstadt-Rhoden, Feldflur am Schartenberg; 51.4558°N, 8.9922°E; 15 Sep. 2024; Dieter Robrecht & Hubertus Trilling leg.; Collection D. Robrecht.

Photographs examined (Host always *T. glaberrima*). – CZECHIA • 1 ♂ 1 ♀ (specimens barcoded); Moravia, Valtice; 48.7368°N, 16.7349°E; 18 Aug. 2006; A. Laštůvka leg.; emerged Mar. 2007; RMNH.5012142, RMNH.5012141; Collection A. Laštůvka. • 1 ♀ (barcoding failed); Moravia, Němčičky; 48.9478°N, 16.8272°E; 13 Aug. 2000; A. Laštůvka leg.; emerged Mar. 2001; RMNH.5012143; Collection A. Laštůvka. • 1 ♂ (Fig. 7); Moravia, Prostejov; 49.47°N, 17.1°E; A. Laštůvka leg.; emerged Mar. 2001; Collection A. Laštůvka. • 1 ♀ (Fig. 8); Moravia, Milovice; 48.849°N, 16.7°E; A. Laštůvka leg.;

emerged Mar. 2001; Collection A. Laštůvka. – GERMANY • 1 mine; Hessen, Diemelstadt-Rhoden, Feldflur am Schartenberg; 51.4558°N, 8.9922°E; 13 Sep. 2024; Hubertus Trilling leg.; https://observation.org/observation/327910701/. • 1 mine; Rheinland-Pfalz, BIT Hüttingen an der Kyll; 49.9608°N, 6.5947°E; 26 Aug. 2023; Alexander Franzen leg.; https://observation.org/observation/285968698/. • 1 mine; same locality data as previous; 07 Sep. 2024; Alexander Franzen leg.; https://observation.org/observation/327389394/. • 2 mines; Rheinland-Pfalz, BIT Messerich; 49.94597°N, 6.45992°E; 17 Sep. 2023; Alexander Franzen leg.; https://observation.org/observation/288425626/. • 1 larva (Fig. 32); Thüringen, , KYF Ochsenburg; 51.3873°N, 11.0389°E; 27 Jul. 2024; Alexander Franzen leg.; https://observation.org/observation/321525068/. – HUNGARY • 1 mine; Budakeszi, Hársbokorhegy; [47.535°N, 18.922°E]; Aug. 1952; L. Gozmány leg.; Budapest. • 9 mines [on 3 herbarium sheets]; Nadap; [47.26°N, 18.61°E]; 12–13 Aug. 1951, 14 Sep. 1951, 12 Oct. 1951; L. Gozmány leg.; HNHM.

Additional observation. – SLOVAKIA • Larva, leafmines; Banská Bystrica, Šiatorská Bukovinka; [48.1653°N, 19.7957°E]; 07 Sep. 2023, A. Laštůvka & Z. Laštůvka leg.

Stigmella mespilicola (Frey, 1856)

Figs 9, 10, 28, 29, 31, 42, 43, 46–52

Nepticula mespilicola Frey, 1856: 392. Holotype ♂ **Switzerland**, Zürich, Uetliberg (ca. 47.35°N, 8.49°E), mines on *Amelanchier*, emerged 1856, Frey collection, Genitalia slide BM21825 (NHMUK. Illustrated in watercolour by R. Johansson in Johansson and Nielsen (1990) and van Nieukerken et al. (2016).

Nepticula ariella Herrich-Schäffer, 1860: 60. Syntypes **Germany:** [Regensburg], "Raupe im Herbste in den Blättern von *Sorbus aria*". Depository unknown, types probably lost. Synonymised by Frey (1880: 422) under the name "Ariae H.-S.". [colour plate published later, Herrich-Schäffer (1861: 32, f. 168)].

Stigmella ariella (Herrich-Schäffer, 1860) Klimesch 1948: 57, new combination, male genitalia.

[*Stigmella mespilicola* (Frey, 1856) Klimesch 1948: 57, new combination. Misidentification for *S. hybnerella* (Hübner, 1796)].

Stigmella cotoneastri sensu Klimesch, 1948: 60.

Stigmella mespilicola; important citations: Johansson and Nielsen 1990; Laštůvka and Laštůvka 1997; Robrecht et al. 2024.

Recognition. Adult (Figs 9, 10, 51). Forewing length ♂ 1.7–2.2 mm (2.0 ± 0.2, n = 6), ♀ 2.3 mm (n = 2), wingspan ♂ 3.9–4.8 mm (n = 6), ♀ 5.0–5.3 (n = 2); antennae ♂ with 23–29 articles (26.7 ± 2.3, n = 6), ♀ with 22–24 (n = 2). *Stigmella mespilicola* is most similar to *S. hybnerella* (Hübner, 1796), but differs by darker, strongly shining copper brown forewing, purple along costa and black head in all specimens. Several *S. hybnerella* specimens, especially females, have a brown or yellowish hair tuft. In doubt genitalia should be examined. From *S. torminalis* it differs by the narrower, more distal and silver fascia and in the male by the presence of black androconial scales on the hindwing.

Male genitalia (Figs 42, 43). Very different from most *Stigmella* species, except *S. hybnerella*, see figures. In comparison with *S. hybnerella* (Fig. 44), the valvae are shorter and do not reach the tip of the uncus in ventral view (they do reach that tip in *S. hybnerella*), the phallus is somewhat shorter, without the 3–4 large cornuti at the apex.

Female genitalia (Fig. 46). As those of *S. hybnerella* with a strongly coiled accessory sac, with about four convolutions (6–7 in *S. hybnerella*, Fig. 45).

Leafmines (Figs 28, 29, 31, 47–50). Egg more often on leaf upperside than underside, in ca 100 mines 28% was on underside, but for mines in *Torminalis* this percentage is 40% (n = 73); usually not on or near a vein, but upperside eggs may be sometimes deposited on top of a vein. Mine starts as an often rather contorted gallery, sometimes later following a vein for a short stretch, black frass line rather wide, in early mine often about half mine width in middle; frass often broken in several places, often distinctly zigzagging, in later mine usually not more than 1/3 mine width. Some

Figures 42–46. *Stigmella mespilicola* and *S. hybnerella*, genitalia for comparison. **42, 43.** *S. mespilicola*, male genitalia, slides SMNS3452 (Lemberg), EvN3359 (Italy, Cuneo); **44.** *S. hybnerella*, male genitalia, slide EvN3949, Italy, Cuneo, Valdieri (ZMUC); **45, 46.** Accessory sac of bursa copulatrix in females, resp. *S. hybnerella*, slide JCK7864, Bulgaria, Sofia, Vitoshia (SOFM) and *S. mespilicola*, slide EvN5468 (Urach). Scale lines: 100 µm.

mines have frass as narrow as in *S. torminalis*, but then more broken and less continuous. Margins of mine irregular, often bulged.

Larva: pale whitish yellow, prothoracic sclerite pale brown to almost invisible, paired brains pale brown and well visible, larva with dorsum upwards.

Cocoon: dark brown.

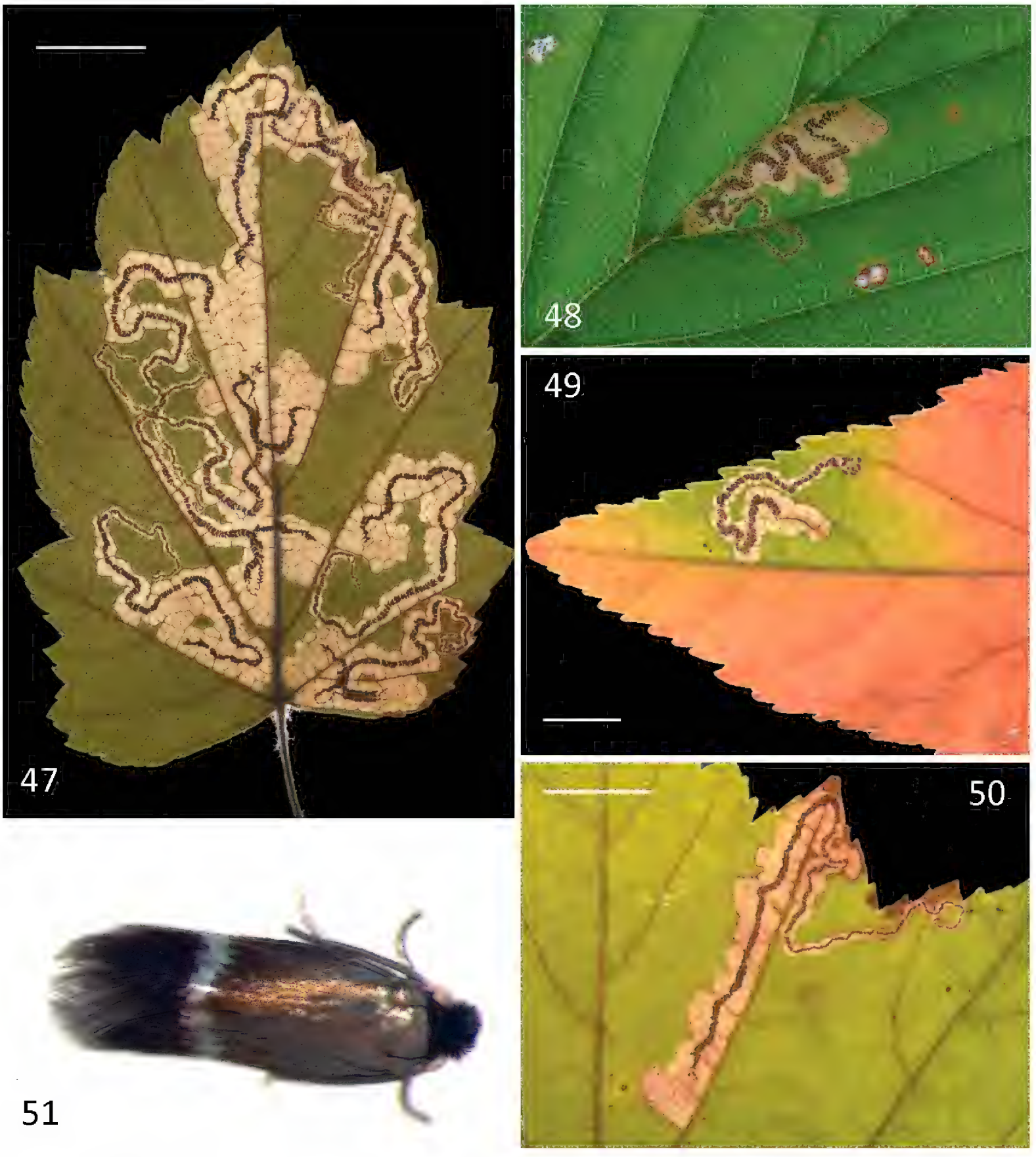
Distribution (Fig. 52). Albania (new record, https://observation.org/observation/291620627/), Austria, Belgium (Wullaert 2017), Bosnia (new record), Bulgaria (new record), Croatia, Czechia, France (van Nieukerken et al. 2006) (new for departments 05, 06, 21, 31, 53, 55, 72), Germany (new for Niedersachsen, https://observation.org/observation/296867262/), Hungary, Italy, Luxemburg (new record, https://observation.org/observation/325644295/), Serbia, Slovakia, Slovenia (Maček 1999), Spain (van Nieukerken et al. 2004), Switzerland, Turkey (Klimesch 1978) and United Kingdom (England) (Emmet 1988; Agassiz 1992) (general references for distribution (Johansson and Nielsen 1990; Laštůvka and Laštůvka 1997; van Nieukerken 2018).

Hostplants. Reared from *Amelanchier ovalis*, *Aria edulis*, *Cormus domestica* (L.) Spach (= *Sorbus domestica*), *Cotoneaster integerrimus* Medik., and *Torminalis glaberrima*. Records from *Crataegus* are certainly wrong (e.g. by Hering 1957; Maček 1999). Leafmines on *Cotoneaster racemiflorus* (Desf.) K. Koch (Klimesch 1978), *Hedlundia mougeotii* (Soy.-Will. & Godr.) Sennikov & Kurtto, *Karpatiosorbus degenii* (Ellis 2024), *K. latifolia* (Lam.) Sennikov & Kurtto and *K. semiincisa* (Borbás) Sennikov & Kurtto (the last four published as species in *Sorbus*) probably also belong to *S. mespilicola*. Szőcs (1981b) recorded *Sorbus aucuparia* as host of *Stigmella torminalis* (specimen and leafmine cited below from Rupphegy). This represents a double misidentification, the reared moth being *S. mespilicola* and the host *Cormus domestica*. Another herbarium sample (Harshegy, 19.vii.1958) was similarly identified, but no reared adult was available. Although the mine could belong to *S. mespilicola*, the identity of the host is uncertain, as *Sorbus aucuparia* is very rare to almost absent in Hungary (Räty et al. 2016), and leaves cannot be reliably separated from *C. domestica*.

Life history. Bivoltine. Larvae are found from early June to July and from late August to October. Adults emerged respectively from late June to July, and from March to May.

DNA barcoding (Fig. 53). We have ten DNA barcodes, seven from our own projects, three from the "Lepidoptera of the Alps" projects, eight of which have all BIN BOLD:ABW6508, and two incomplete barcodes. The Maximum distance between these is 2.16%, the average distance 1.29%, nearest neighbour is the not closely related *Stigmella fasciata* van Nieukerken & Johansson, 2003, at a distance of 4.9%.

Remarks. On the basis of the genitalia figures in Klimesch (1948), the species feeding on *Amelanchier* was considered to be *S. hybnerella*, with exceptions (van Nieukerken 1986). Also a male reared from *Amelanchier* by Axel Scholz (collection Stuttgart) proved to be a *S. hybnerella*, but the holotype of *S. mespilicola* was also reared from *Amelanchier*. Apparently both species feed on *Amelanchier*, and we have no indication whether one of these is commoner than the other one. Rearing larvae or obtaining DNA barcodes is necessary to obtain a better idea of the distribution of both species on this host. Probably the mines of *S. hybnerella* on *Amelanchier* are more a linear-blotch type mine, and those of *mespilicola* linear, as on other hosts, but we have seen insufficient mines with a certain identification. Many records of this species on *Torminalis* were originally misidentified as *Stigmella torminalis*, see discussion above.



Figures 47–51. *Stigmella mespilicola*, biology. **47.** Germany, Lemberg vi.1937, vacated mines on *Torminalis glaberrima*; **48.** Germany, Bad Münster am Stein, vacated mine on *Aria edulis*; **49.** Belgium, Lavaux-Sainte-Anne, mine with dead barcoded larva on *T. glaberrima*, RMNH.INS.31389; **50.** France, Chauvoncourt, vacated mine on *T. glaberrima*, RMNH.INS.38650; **51.** Live male, France, Fessenheim, reared from *Torminalis glaberrima*, RMNH.INS.1556810 (same moth as Fig. 10). Scale lines: 5 mm.

Otherwise most literature references are reliable, with the exception of records on *Aria* (and hybrids) in the north of the British Isles (e.g. on GBIF) and Scandinavia, where *S. magdalenae* is often found feeding on these. The record from Turkey by Klimesch (1978) is also uncertain, as it is based on a single record of vacated mines on *Cotoneaster* Medik. and a female reared from *Amelanchier*, of which the genitalia have not been checked, and which could also belong to

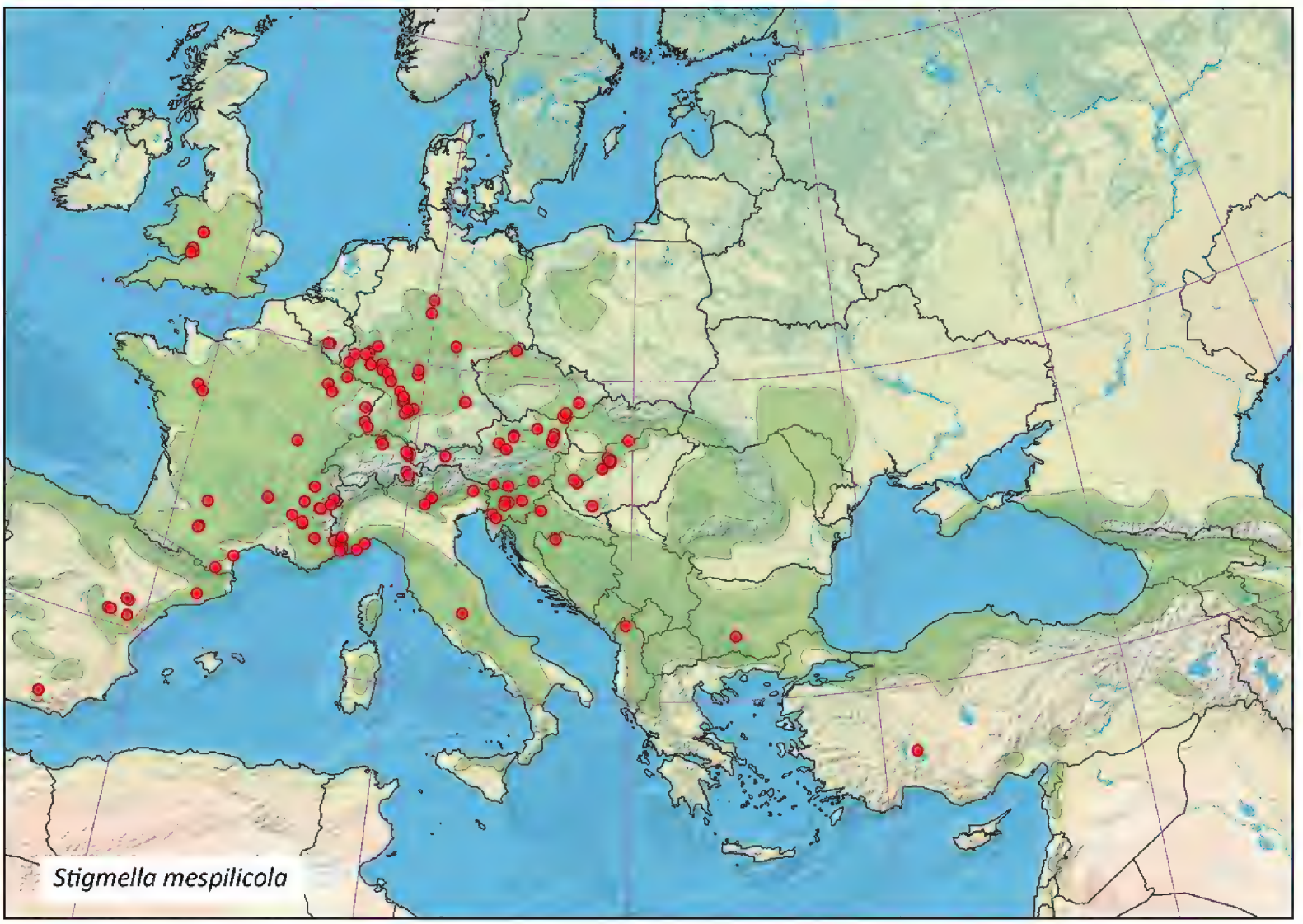


Figure 52. Distribution records of *Stigmella mespilicola*, mapped on the distribution area of *Torminalis glaberrima* (solid green).

S. hybnerella. In fact the illustrated leafmines on *Amelanchier* (Klimesch 1978: figs 3a, 3b), linear-blotch mines, resemble more those of *S. hybnerella*, whereas that on *Cotoneaster* (Fig. 4) could well be a *S. mespilicola* mine.

Material examined. Specimens cited from France and Spain earlier by van Nieukerken et al. (2004, 2006) are not repeated.

Adults. – FRANCE • 1 ♂ 1 ♀; Alpes de Hautes-Provence, Digne; [44.09°N, 6.23°E]; 10 Sep. 1967; J. Klimesch leg.; Host: *Cormus domestica*; emerged 17 Mar.–01 Apr. 1968; EventId: Zucht No. 931; ZSM. . – GERMANY • 2 ♀; Baden-Württemberg, Bad Ditzenbach, Leimbg., Kreuzkp. [Leimberg, Kreuzkapelle]; [48.584°N, 9.673°E]; alt. 700 m; 09 Sep. 1989; A. Scholz leg.; Host: *Aria edulis*; SMNS. • 2 ♂; Baden-Württemberg, Affalterbach, "Lemberg"; [48.82°N, 9.14°E]; alt. 360 m; 19 Sep. 1995; A. Scholz leg.; Host: *Torminalis glaberrima*; SMNS. • 1 ♂ 1 ♀; Baden-Württemberg, Urach Umg., Hohenwittlingen; [48.47°N, 9.423°E]; 01 Sep. 1989; A. Scholz leg.; Host: *Cotoneaster integerrimus*; SMNS. Genitalia slide: EvN5468 ♀; DNA extract RMNH.INS.25468; SMNS. • 1 ♂; Baden-Württemberg, Lemberg Zuffh.; [48.82°N, 9.14°E]; [20 Sep. 1936]; A. Wörz leg.; Host: *T. glaberrima*; emerged 07 Mar. 1937; Genitalia slide: SMNS3452; SMNS. • 1 ♀; same locality data; [05 Jun. 1937]; A. Wörz leg.; Host: *T. glaberrima*; emerged 22 Jun. 1937; SMNS [both identified and published by Wörz as *Nepticula torminalis*]. • 1 ♂; Baden-Württemberg, Lemberg-Horn; [48.817°N, 9.131°E]; A. Wörz leg.; Host: *T. glaberrima*; emerged 13 Jul. 1944; Genitalia slide: on pin; SMNS [identified and published by Wörz as *Nepticula torminalis*]. • 1 ♀; Thüringen, Bad Blankenburg; [50.68°N, 11.27°E]; H. Steuer leg.; Host: *T. glaberrima*; emerged 13 Jun. 1969; Genitalia slide: EvN3145; Steuer collection, MfN [as *Stigmella torminalis* in Steuer 1984, corrected by Steuer 1991]. – HUNGARY • 1 ♂ 1 ♀; Budapest, Normafa; 47.504°N, 18.965°E; 09 Jun. 1973; J. Szőcs leg.; Host: *T. glaberrima*; emerged 02–03 Jul. 1973; EventId: Zucht: 79/73; Genitalia slides: VU1755, VU1756; HNHM [as *Nepticula torminalis* in

Szőcs 1981a]. . – ITALY • 1 ♂; Cuneo, Entracque-S.Giacomo, Vallone della Barra: Gias della Siula; [44.146°N, 7.376°E]; alt. 1600 m; 25 Jul. 2000; G. Baldizzone leg.; Genitalia slide: EvN3359; Baldizzone, G., personal collection. • 1 ♂; Savona, Conna; [43.98°N, 8.11°E]; E. Jäckh leg.; emerged 04 May 1970; Genitalia slide: RJ1134; ZMUC. • 1 ♂ (Fig. 9) 1 ♀; Savona, Noli; [44.21°N, 8.41°E]; 20 Sep. 1952; J. Klimesch leg.; Host: *Cormus domestica*; emerged 10–27 Mar. 1953; Genitalia slide: EvN4240; DNA extract RMNH.INS.24240; ZSM. – SWITZERLAND • 1 ♀; Zürich, Zürich, [Uetliberg]; [47.351°N, 8.491°E]; Frey leg.; Host: *A. edulis*; Genitalia slide: BM21826; NHMUK. – UNITED KINGDOM • 1 ♀; England, Lord's Wood; [51.83°N, 2.65°W]; A.N.B. Simpson leg.; Host: *T. glaberrima*; emerged 1984; Genitalia slide: BM24099; NHMUK.

Leafmines and larvae. – AUSTRIA • 6 mines; Niederösterreich, Gumpoldskirchen: Glaslauterriegel; 48.0303°N, 16.2507°E; alt. 300–340 m; 01 Oct. 1983; van Nieukerken & Boomsma leg.; host: *A. edulis*; EventId: VU no. 83322; ZMA.INS.MIG.12045; RMNH. • 15 mines; same locality data as previous; host: *Torminalis glaberrima*; EventId: VU no. 83323; ZMA.INS.MIG.12048; RMNH. • 1 mines; Niederösterreich, Dürnstein; [48.4°N, 15.52°E]; 09 Sep. 1933; J. Klimesch leg.; host: *A. edulis*; SMNS. • 5 mines; Wien, Kahlenberg, SE slope; 48.276°N, 16.342°E; alt. 400 m; 25 Oct. 1983; E.J. van Nieukerken leg.; host: *A. edulis*; EventId: VU no. 83542; ZMA.INS.MIG.12044; RMNH. • 6 mines; Wien, Leopoldsberg, W. [recte E.] of Kahlenberg; 48.277°N, 16.35°E; alt. 200–425 m; 25 Oct. 1983; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: VU no. 83540; ZMA.INS.MIG.12049; RMNH. – BELGIUM • 1 larva, 1 mine; Namur, Rochefort, Belvaux, Tienne de Boton; 50.1113°N, 5.1832°E; alt. 200 m; 20 Aug. 2016; Bladmijnenwerkgroep leg.; host: *T. glaberrima*; RMNH.INS.30885 (barcoded larva) RMNH.INS.39199 (mine); RMNH. • 2 larvae, 2 mines (Fig. 49); Namur, Rochefort, Lavaux-Sainte-Anne, Le Gros Tienne; 50.1064°N, 5.1003°E; alt. 225 m; 16 Sep. 2019; Chris Steeman leg.; host: *T. glaberrima*; slides: RMNH.INS.31389.P, RMNH.INS.31390.P; RMNH.INS.31389, RMNH.INS.31390 (barcoded larvae); RMNH. – BOSNIA-HERZEGOVINA • 9 mines; Republika Srpska, Brezičani, 5 km NW Prijedor; 45.014°N, 16.669°E; 17 Oct. 1983; van Nieukerken & Boomsma leg.; host: *T. glaberrima*; EventId: VU no. 83494; ZMA.INS.MIG.12050; RMNH. – BULGARIA • 1 larva, mine; Pazardzhik, Peshtera, 8.5 km ESE; 42.00261°N, 24.39357°E; alt. 765 m; 22 Jul. 2013; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: EvN no 2013060-M; slide: RMNH.INS.29681.P; RMNH.INS.29681 (barcoded larva), RMNH.INS.40725 (mine); RMNH. – CZECHIA • 1 mine; Jihomoravsky Kraj, Lednice, castle gardens; 48.79297°N, 16.7973°E; 03 Oct. 1992; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: EvN no 92055; RMNH.INS.49722; RMNH. – FRANCE • 3 mines; Alpes-Maritimes, Breil-sur-Roya, 1.9 km SW, E of Col de Brouis; 43.92684°N, 7.49657°E; alt. 1045 m; 09 Oct. 2008; E.J. van Nieukerken & C. Doorenweerd leg.; host: *A. edulis*; EventId: EvN no 2008166–1H; RMNH.INS.42406; RMNH. • 3 mines; Alpes-Maritimes (06), S. of Baisse du Pâpe, E. slopes, ca 4.2 km SW of Sospel; 43.85035°N, 7.40994°E; alt. 1050 m; 08 Oct. 2008; E.J. van Nieukerken & C. Doorenweerd leg.; host: *A. edulis*; EventId: EvN no 2008161-H; RMNH.INS.42394; RMNH. • 1 mine; Hautes Alpes (05), La Grave, 2 km E Les Clots; 45.0383°N, 6.2111°E; alt. 1135 m; 21–24 Aug. 2017; M. Kozlov & V. Zverev leg.; host: *A. edulis*; EventId: ecological sample 13; RMNH.INS.46083; RMNH. • 1 mine; Hautes Alpes (05), La Romanche, 2 km W Les Fréaux; 45.0414°N, 6.2617°E; alt. 1350 m; 21–24 Aug. 2017; M. Kozlov & V. Zverev leg.; host: *A. edulis*; EventId: ecological sample 10; RMNH.INS.46073; RMNH. • 3 mines; Meuse (55), Chauvoncourt, Pelouses et vallons forestiers de Chauvoncourt – N2000; 48.89015°N, 5.50219°E; alt. 293 m; 26 Jul. 2024; E.J. van Nieukerken leg.; host: *A. edulis*; EventId: EvN no 2024064-H; RMNH.INS.38647; RMNH. • 5 mines; same locality data as previous; 48.88963°N, 5.50107°E; alt. 296 m; 26 Jul. 2024; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: EvN no 2024065–1H, 3H; RMNH.INS.38648, RMNH.INS.38650; RMNH. • 5 mines; Meuse (55), Koeur-la-Grande, Pelouses et vallons forestiers de Chauvoncourt – N2000; 48.86924°N, 5.47558°E; alt. 271 m; 26 Jul. 2024; E.J. van Nieukerken leg.; host: *A. edulis*; EventId: EvN no 2024066-H; RMNH.INS.38653; RMNH. • 1 mine; same locality data as previous; 48.86885°N, 5.47551°E; alt. 270 m; 26 Jul. 2024; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: EvN no 2024068-H; RMNH.INS.38655; RMNH. • 1 mine; Meuse (55), Pagny-sur-Meuse, Chapelle de Massey; 48.66367°N, 5.7259°E; alt. 288 m; 25 Jul. 2024; E.J. van Nieukerken leg.; host: *T. glaberrima*; EventId: EvN no 2024060–1H; RMNH.INS.38643; RMNH. – GERMANY • 1 mine; Baden-Württemberg, Badenweiler, Waldweg, between Badenweiler and Sophienruhe; [47.798°N, 7.673°E]; 21 Sep.

2001; AC & WN Ellis leg.; host: *A. edulis*; ZMA.INS.MIG.07775; RMNH. • 2 mines; Baden-Württemberg, Stromberg, Leonbronn; [49.063°N, 8.897°E]; 17 Oct. 1934; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 1 mine; Baden-Württemberg, Stuttgart, Dachswald; [48.743°N, 9.108°E]; 20 Sep. 1936; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 1 larva, 1 mine; Baden-Württemberg, Tauberbischofsheim, Hunsenberg; [49.6479°N, 9.63°E]; alt. 285 m; 04 Sep. 2023; M. König leg.; host: *T. glaberrima*; RMNH.INS.39795; RMNH. • 1 larva, 6 mines; Baden-Württemberg, Tauberbischofsheim, Hunsenberg; 49.6502°N, 9.627°E; alt. 290 m; 04 Sep. 2023; M. König leg.; host: *T. glaberrima*; RMNH.INS.39799; RMNH. • 29 mines (Fis. 28, 29, 47); Baden-Württemberg, Zuffenhausen, Lemberg; [48.82°N, 9.14°E]; 16 Oct. 1932, 27 Jul. 1935, 05 Jun. 1937, 18 Jun. 1938; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 12 mines; Baden-Württemberg, Feuerbach-Lemberg; [48.82°N, 9.14°E]; 21 Jun. 1944; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 1 mine; Baden-Württemberg, Hall [illegible]; A. Wörz leg.; host: *A. edulis*; SMNS. • 7 mines; Baden-Württemberg, Lindental; [48.812°N, 9.129°E]; 23 Aug.–08 Sep. 1948; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 6 mines; Baden-Württemberg, Linsenbühl bei Honau; [48.408°N, 9.258°E]; 18 Aug. 1935; A. Wörz leg.; host: *A. edulis*; SMNS. • 7 mines; Baden-Württemberg, Markgröningen; [48.91°N, 9.09°E]; 07 Jun. 1948; A. Wörz leg.; host: *T. glaberrima*; SMNS. • 1 mine; Baden-Württemberg, Neufen (Alb); [48.55°N, 9.37°E]; A. Wörz leg.; host: *A. edulis*; SMNS. • 1 larva, 9 mines; Bayern, Humburg-am-Main, Kullmuth; 49.80394°N, 9.62322°E; alt. 275 m; 24 Aug. 2023; M. König leg.; host: *A. edulis*; RMNH.INS.31740 (barcoded larva), RMNH.INS.39024 (mines); RMNH. • 4 mines; Rheinland Pfalz, Bad Münster am Stein, W Schloß Rheingrafenstein; 49.8060°N, 7.8479°E; Buchen-Eichenmischwald; 07 Oct. 2022; D. Robrecht leg.; host: *A. edulis*, Collection D. Robrecht. • 1 mine; Rheinland Pfalz, Idar-Oberstein; 07 Oct. 2022; A. Werno leg.; host: *T. glaberrima*; Collection D. Robrecht. – ITALY • 9 mines; Pordenone, 5 km E of Tramonti di Sopra, pass; 46.302°N, 12.849°E; alt. 900 m; 08 Oct. 1983; van Nieukerken & Boomsma leg.; host: *A. edulis*; EventId: VU no. 83401; ZMA.INS.MIG.12046; RMNH. • 2 mines; Savona, Liguria, Noli; [44.21°N, 8.41°E]; 03 Sep. 1964; J. Klimesch leg.; host: *Cormus domestica*; ZMA.INS.MIG.02191; RMNH. • SLOVENIA • 5 mines; Obalno-kraška, Mt. Slavnik, 8 km S Herpelje-Kozina [Hrpelje]; 45.533°N, 13.975°E; alt. 900–1000 m; 14 Oct. 1983; van Nieukerken & Boomsma leg.; host: *A. edulis*; EventId: VU no. 83457; ZMA.INS.MIG.12047; RMNH.

Photos examined. – **Adults**. – HUNGARY [all originally identified and published as *Nepticula* or *Stigmella torminalis*] • 1 ♂; Budapest, Hársbokorhegy; [47.535°N, 18.922°E]; J. Szőcs leg.; host: *T. glaberrima*; emerged 05 May. 1953; HNHM. • 1 ♂; Budapest, Normafa; [47.504°N, 18.965°E]; J. Szőcs leg.; host: *T. glaberrima*; emerged 07 Aug. 1962; HNHM. • 1 ♂; same locality and host data as previous; 06 Jul. 1964; J. Szőcs leg.; emerged 24 Jul. 1964; HNHM. • 1 ♂; Budapest, Rupphegy; [47.474°N, 18.978°E]; 17 Jun. 1978; J. Szőcs leg.; host: *Cormus domestica* [labelled as from *Sorbus aucuparia*]; emerged 08 Jul. 1978; Zucht: 28/64; HNHM. • 1 ♀; Budapest, Ságvári-liget [now Szépjuhászné]; [47.528°N, 18.955°E]; 16 Jul. 1963; J. Szőcs leg.; host: *T. glaberrima*; emerged 04 Aug. 1963; HNHM. • 1 ♂ 1 ♀; same locality and host data as previous; emerged 10 & 21 May 1963; HNHM. – SWITZERLAND • 1 ♀; Zürich, Weiningen, Altberg; [47.433°N, 8.413°E]; 19 Oct. 1935; P. Weber leg.; host: *T. glaberrima*; emerged 14 May. 1936; ETZ [published as *S. torminalis* by Weber 1945].

Leafmines. – HUNGARY (herbarium sheets, most originally identified as *Nepticula/Stigmella torminalis*, some as *N. ariella*; all in HNHM) • 11 mines (Fig. 31); Badacsony; [46.799°N, 17.495°E]; 12 Jul. 1967 & 14 Sep. 1967; J. Szőcs leg.; host: *T. glaberrima*. • 5 mines; Budapest, Hármashatárhegy; [47.556°N, 19°E]; alt. 460–490 m; 22 Jul. 1964; J. Szőcs leg.; host: *A. edulis*. • 3 mines; Budapest, Hárshégy; [47.533°N, 18.959°E]; alt. 350–400 m; 19 Jul. 1958; J. Szőcs leg.; host: *Sorbus aucuparia* [probably misidentification for *Cormus domestica*, see above]. • 2 mines; Budapest, Nagykovácsi, Kis Szénás; [47.605°N, 18.847°E]; 03 Sep. 1963; J. Szőcs leg.; host: *T. glaberrima*. • 3 mines; Budapest, Normafa; [47.504°N, 18.965°E]; Sep. 1950; J. Szőcs leg.; host: *Karpatiosorbus semiincisa*. • 1 mines; same locality data as previous; 06 Jul. 1964; J. Szőcs leg.; host: *T. glaberrima*; EventId: Zucht: 28/64. • 22 mines; same locality data as previous; 09 Jun. 1973; J. Szőcs leg.; host: *T. glaberrima*; EventId: Zucht: 79/73, 80/73.• 1 mine; Budapest, Rupphegy; [47.474°N, 18.978°E]; 17 Jun. 1978; J. Szőcs leg.; host: *Cormus domestica* [on label as *Sorbus aucuparia*]; EventId: Zucht: 22/78. • 2 mines; Budapest, Ságvári-liget [now Szépjuhászné]; [47.528°N, 18.955°E]; 16 Jul. 1963; J. Szőcs leg.; host: *T. glaberrima*; EventId: Zucht: 35/63. • 3 mines; same locality data as previous; 06 Jun. 1973; J. Szőcs leg.; host: *T. glaberrima*; EventId: Zucht: 73/73. • 11 mines; Nadap; [47.26°N, 18.61°E]; 14

Sep. 1951; L. Gozmány leg.; host: *T. glaberrima*. • 12 mines; Pécs, Mecsek, Misina; [46.099°N, 18.219°E]; 18 Oct. 1965; J. Szőcs leg.; host: *T. glaberrima*. • 1 mines; Uzsa, Nyires; [46.897°N, 17.333°E]; 27 Aug. 1968; J. Szőcs leg.; host: *A. edulis*.

Key to the linear leafmines on *Torminalis*

Older records of *Stigmella hybnerella* and *S. magdalenae* on *Torminalis* could not be confirmed and are probably incorrect (Ellis 2024) and these species are thus not included in the key. Although we have not found positive records of *Lyonetia clerkella* (Linnaeus, 1758) on *Torminalis*, we include it here as this species is oligophagous on many Rosaceae trees and to be expected to use this host as well.

1 No egg at start of mine. Mine very long, throughout much of the leaf, thin and meandering, rarely following veins. Final empty part of vacated mine 3–4 times as long as wide. Larva whitish, constricted between segments, six legs visible from above as black dots. ..... ***Lyonetia clerkella***

– Mine start with small egg scale. Mine not so long, often for parts following veins. Final empty part of vacated mine less than 3 times as long as wide. Larva yellow or green, with segments not clearly constricted, legs absent..... **2**

2 Egg on leaf upperside, close to midrib. Leafmine very short, ca. 1 cm, and compact against midrib. Larva later makes windows on leaf underside ..... ***Bucculatrix bechsteinella***

– Egg on leaf upperside, often away from veins, sometimes on a vein. Leafmine much longer ..... ***S. mespilicola***

= Egg on leaf underside, often against a vein. Leafmine much longer..... **3**

3 Frass almost filling most of gallery, in zigzag coils, green or brown; larva green..... ..... ***S. hahniella***

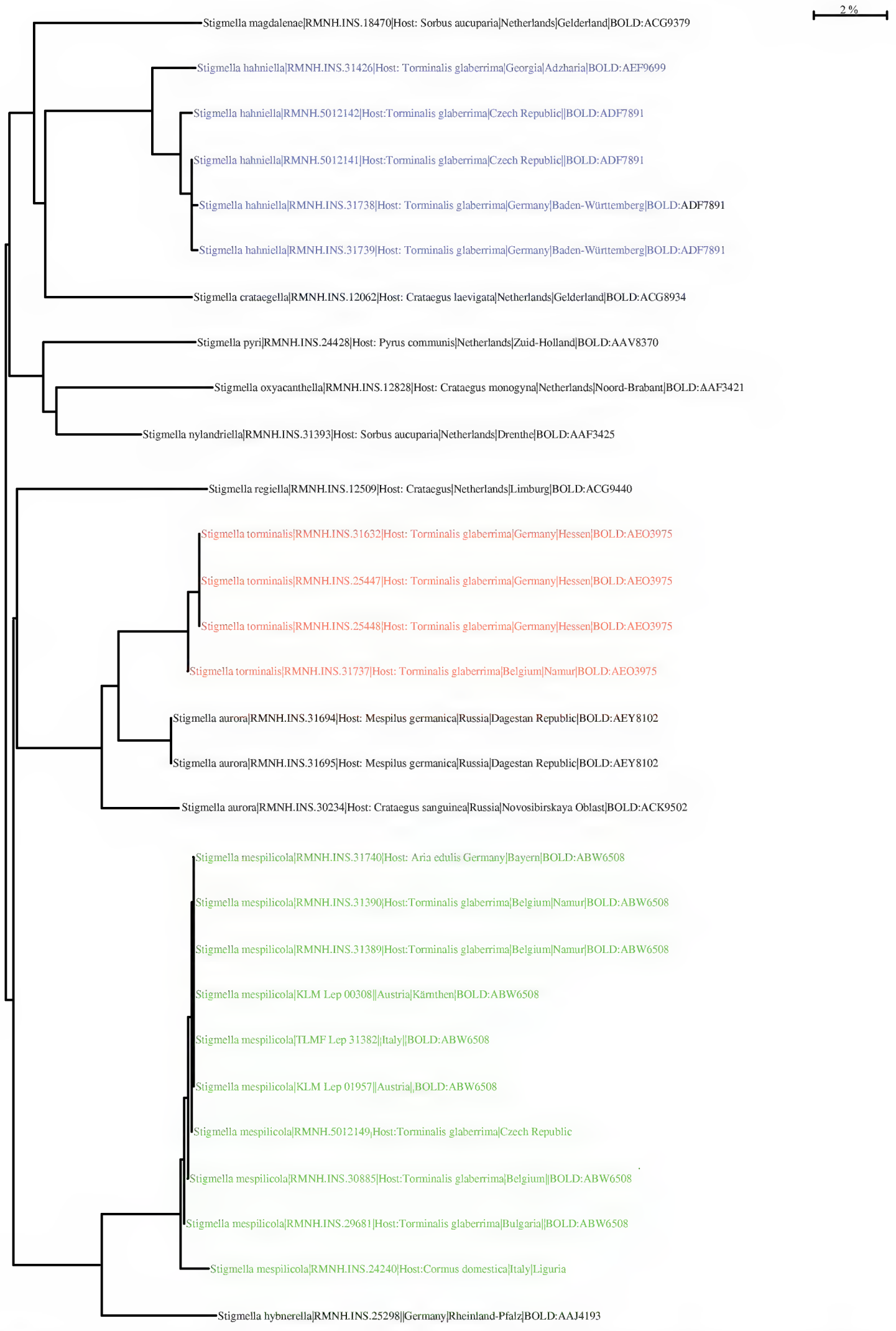
– Frass not filling gallery completely, leaving distinct clear margins; larva yellow, in mine often appearing whitish..... **4**

4 Frass in mine in an almost continuous thin line, less than 1/3 of mine width; margins of early mine rather regular, straight; early mine often somewhat angular. Larva with pair of almost black prothoracic sclerites, giving the head a black appearance. Larvae only in June-August ..... ***S. torminalis***

– Frass more irregular, often broken, in parts often thicker than 1/3 of mine, but sometimes thin throughout; margins of mine irregular, bulged. Larval prothoracic sclerite pale brown to almost indistinct. Larvae in two generations, June-August, September-November..... ***S. mespilicola***

Discussion

After many decades without observations, the rare species *Stigmella torminalis* and *S. hahniella*, both feeding on *Torminalis glaberrima*, were rediscovered in Germany and some other parts of Europe. The explanation for this is twofold: until recently the study of leafmining moths in Central Europe was neglected, but recently revived due to a number of causes: the start of a group of German amateurs and professionals studying Microlepidoptera, who meet each year in October, when leafmines are abundant; and secondly the enormous increase of natural history observations due to internet platforms such as Observation.org and iNaturalist. The recent publication



Figures 53. Neighbor-Joining tree of partial COI sequences (DNA barcodes) of species of the *Stigmella oxyacanthella* and *S. hybnerella* groups (dataset DS-STITOR), under the Pairwise Distance model. The labels provide data on Sample Id, Host (if known), Country, Province and Bold Identification Number.

of an identification book for Nepticulidae in Germany and the fieldwork in preparation for that (Robrecht et al. 2024) was the immediate cause of the rediscovery of *S. torminalis*.

A second reason, particularly in the case of *S. torminalis*, is the previous lack of properly identified leafmines, which made identification almost impossible, as the existing literature for a long time had confused the species *S. torminalis* and *S. mespilicola*, including the well-known leafmine identification keys (Hering 1957). Also the unusual timing of *S. torminalis* larvae in early summer and not in autumn, unlike most Nepticulidae, adds to the lower chance of finding this species. Thanks to rearing adults, the study of genitalia and DNA barcoding we have been able to distinguish the larvae and leafmines of these two species in most cases. For the reconstruction of the distribution, it is important that museums keep not only the collections of the insects proper, but also the leafmines. Such collections are often undervalued, sometimes even forgotten, but very important to verify old records, as was shown here and earlier (van Nieukerken 2023).

Focused searching for leafmines on the rather rare host tree has been shown to give results in Germany and France. It is remarkable that France, where probably the largest populations of *Torminalis* grow, had no records of these two species before 2024, most likely due to a lack of interest in these leafmines. Also the number of records of *S. mespilicola* is very low. *Stigmella torminalis* is still unknown from France, but almost certainly will be found there when searched for; localities in Belgium and Germany are not far away from its borders. Hopefully this paper will be an impetus for looking in more places for *Stigmella torminalis* and the other species on *Torminalis* trees.

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